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POLLUTION OF THE NAVIGABLE WATERS OF WESTERN SOUTH DAKOTA. PROCEEDINGS OF CONFERENCE HELD AT RAPID CITY, SOUTH DAKOTA ON OCTOBER 19-21, 1971. TRANSCRIPT OF PROCEEDINGS

Environmental Protection Agency
Washington, D. C.

19 October 1971

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CONFERENCE

IN THE MATTER OF
POLLUTION OF THE NAVIGABLE WATERS
OF
WESTERN SOUTH DAKOTA

held at

Rapid City, South Dakota
October 19-21, 1971

TRANSCRIPT OF PROCEEDINGS

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Conference in the Matter of Pollution of the Navigable Waters of Western South Dakota convened at 9:30 o'clock on October 19, 1971, in the Alex-Johnson Hotel, Rapid City, South Dakota.

PRESIDING:

Mr. Murray Stein
Chief Enforcement Officer - Water
U. S. Environmental Protection Agency
Washington, D. C.

ALSO PRESENT:

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Deputy Assistant Administrator
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ALSO PRESENT:

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PROCEEDINGS

MR. STEIN: The conference is open.

This conference was called at the request of the Governor of South Dakota and it is indeed a privilege and a pleasure to present at this time Governor Richard Kneip.

HON. RICHARD F. KNEIP
GOVERNOR
STATE OF SOUTH DAKOTA

GOV. KNEIP: Good morning.

Especially to those of you from outside South Dakota, may I first of all welcome you here. I appreciate your coming the miles that you have for the problem which we face here in South Dakota.

I have had enough controversies, gentlemen, to last me a lifetime, and when I look back over the months that I have been in this office and to those many controversies, I am often amused at the fact that there are so many interpretations of things that I say these days. And if you will bear with me for just a moment, I would like to pass on to you a story I heard the other day that I thought was appropriate and certainly might be appropriate to this occasion, but it talks about the interpretations of what one says, the varying interpretations.

Gov. R. Kneip

The story goes and is told about the minister that was addressing his Sunday school class, and in doing so sought to tell this class of the ill effects of alcohol. To illustrate his point he chose to use two glasses and a live worm. The one glass he filled with plain water, the second glass he filled with whiskey. He took the live worm and placed it first of all in the glass of plain water, left it there for a few moments, extracted it, placed it on the table and the worm, of course, remained healthy and began to crawl away.

He picked up the same worm and put it in the glass of whiskey, left it there for a few moments, placed it on the table and the worm died.

The minister looked out upon his Sunday school class, and he said, "Is there anyone here that can give me an interpretation of what I have shown you through this illustration?"

And one boy quickly raised his hand and he said, "Well, I will tell you one thing, Minister, my dad doesn't have worms." (Laughter.)

I am appreciative of the fact that all of you have taken of your time and are here to express yourselves on something that is vital to all of us. At a time when many in our world are vitally concerned about the hazard of mercury in our environment, I have asked that you come together with the representatives of our State agencies who must of necessity concern themselves with protection of our people and protection of our environment. You have consented to come this distance so that together as State and Federal partners--and I have spoken a great deal over the past months about the partnership relation between the Federal and State Governments and the importance of it--we can work towards the conclusion, the possible conclusion, as to whether mercury in South Dakota is a real or potential toxic problem to man.

I have requested that the conference address itself secondly to the methods of control if such hazards are demonstrated.

Thirdly, I have asked the conference to address itself to the significance of cyanide discharges.

And as a fourth point I have asked the conference to address itself to the occurrence, distribution and significance of heavy metals other than mercury which might be toxic to man.

I would thank the Federal people and Secretary Ruckelshaus for the report entitled "Pollution Affecting Water Quality of the Cheyenne River System, Western South Dakota," as dated September 1971, and say, too, that as a layman I feel it has helped me to gain some understanding--some--some understanding of the problem which I already recognize as complex.

I would thank our State Water Pollution Committee for the work that it has done. They, too, are very interested in the proceedings of this conference as well as the conclusions that it comes to.

Another group which has contributed a great deal to the State's knowledge and has assisted us in formulating a position has been our mercury coordinating committee, which is made up of scientists from our universities as well as our Toxicology Laboratory and our State Health Laboratory. I feel that my State Health Officer, Dr. Hayes, has an awesome responsibility as protector of the public's health. He together with his Health Department staff, the Water Pollution Committee, and the mercury coordinating committee, have not flinched their responsibilities, but at the same time I know they have genuine questions which must be answered in order for them to assume the responsibility of doing all that needs to be done.

And so I would say to the Federal people in particular, to our guests, that we want your help. Our staff values your knowledge. I recognize that your resources have already in part been shared and that you may--you may--conclude jointly that our Federal Government will again have to assist us. I can only promise you that South Dakota stands ready to do what is right and that this conference can assist us greatly in making the right decisions. My staff in the true spirit of this conference may not agree with you gentlemen. I hope that when they do not that they will question you, hold you to your point, will have you satisfactorily explain your stand. Likewise I trust that you will do the same.

Again I thank you for coming. I look forward to the work that you will be doing, to the study, the review, the debate and the testimony that will come from all interested parties. I know that if we work in that light that the deliberation of this conference, which is costly in time, in people and in money, can be meaningful to the entire population of this State.

I thank all of you for coming and I look forward to the report which will come from this conference.

Thank you. (Applause.)

MR. STEIN: Thank you, Governor Kneip.

OPENING STATEMENT

BY

MR. MURRAY STEIN

MR. STEIN: We will continue with the opening statement.

The Governor indicated he had had enough controversy to last a lifetime, but I know that I have been involved with the regulations of mercury discharges and other heavy metals since it became popular a year or two ago and the controversy on that has been tremendous. I think the Governor gave us some very sage words of advice. He has analyzed this problem both as to mercury and other toxic materials which may be being discharged, but if we are going to make any progress in controlling this we have to deal on the basis of facts.

The reason I say this now is because I know how highly charged a field like this can often get. Just lately mercury has come into the fore and no one thought that was a particularly dangerous material, say, until the past two years, and people react strongly to mercury. In this conference you may hear words like arsenic and cyanide, which also have been drummed into us or we are conditioned to it by watching our earliest double feature movie or reading a mystery thriller as to what is happening, and I think while it is very important that we control these materials, we can only do it on the basis of calm analysis and seeing what can be done.

Dr. Wurtz, I think, who is a private consultant and is at this conference, pointed out that we didn't have the 500 or 1,000 people pouring out of the doors of this one that we have had at some of the others, and I answered, I said, well, maybe that is an indication that we may be able to really get down to a factual situation and not have an emotionally charged meeting.

The reason I have taken so much time on this here is I know the nature of the subject and I ask you to join with me in recognizing that the only way we can get at this and begin to solve the problem is by a dispassionate view of the whole situation.

This conference in the matter of pollution of the navigable waters of western South Dakota, particularly involving Whitewood Creek - Belle Fourche River - Cheyenne River System, is being held under the provisions of Section 10 of the Federal Water Pollution Control Act.

Under the provisions of the act, the Administrator of the Environmental Protection Agency is required to call a conference of this type when requested to do so by the Governor of a State. In a letter dated April 23, 1971, to William D.

Ruckelshaus, Administrator, Environmental Protection Agency, Governor Richard F. Kneip of South Dakota requested that a conference be called to consider pollution of the navigable waters of western South Dakota. On the basis of this request, Administrator Ruckelshaus, on June 29, 1971, sent a notice of the conference to the South Dakota Department of Health, which is the official State water pollution control agency. At the Governor's request, the South Dakota Department of Game, Fish and Parks, the South Dakota Water Resources Commission, and the United States Department of Health, Education, and Welfare have also been invited to attend and participate in this conference.

Both the State and Federal Governments have responsibilities in dealing with water pollution control problems. The Federal Water Pollution Control Act declares that the States have primary rights and responsibilities for taking action to abate and control pollution. Consistent with this, we are charged by law to encourage the State in these activities.

At the same time, the Administrator is charged by law with specific responsibilities in the field of water pollution control in connection with the pollution of interstate and navigable waters. The Federal Water Pollution Control Act provides that pollution of interstate or navigable waters which endangers the health or welfare of any persons, shall be subject to abatement. This applies whether the matter causing or contributing to the pollution is discharged directly into such waters or reaches such waters after discharging to a tributary.

The purpose of the conference is to bring together representatives of the State of South Dakota, the Federal Government and other interested parties to review the existing situation, the progress which has been made, to lay a basis for future action by all parties concerned, and to give States, localities, and industries an opportunity to take any indicated remedial action under State and local law.

And I think no more than in the field of control of toxic materials, heavy metals or mercury do we need the cooperation of all interested parties and that is Federal, State, local and industry. Because in working this problem through, I think it is fair to say that the substantial and very dramatic reductions we have gotten, for example, in industrial discharges have been a result of cooperation of all these parties and, in fact, the methodology was developed in almost all cases by the industry, who did respond.

This is one area where we are dealing with putting a toxic material into the environment and we can't afford the luxury, even if we think that way, of State-Federal rights and prerogatives or industrial rights or localities and the ordinary rivalries and tensions between them. We are dealing with very, very potentially dangerous materials and we need all the help we can get and the complete cooperation from all parties concerned. We have had this before and I am confident that we are going to have it again here. If we don't do that and if we don't approach it that way, we very well may have serious problems.

I would like to ask the people at the head table now to introduce themselves. I wonder if we can start at the left.

DR. SHIBKO: I am Sam Shibko. I am in the Division of Toxicology, Food and Drug Administration, Washington, D.C.

MR. RONK: My name is Richard Ronk. I am Chief of the Guidelines Branch, Bureau of Foods, Food and Drug Administration, Washington, D. C.

MR.DICKSTEIN: My name is Irwin Dickstein. I am in the Enforcement Division of Region VIII, Denver, Colorado, EPA.

MR. GREEN: My name is Jack Green. I am the Regional Administrator, Region VIII, Denver.

DR. HAYES: My name is Robert Hayes. I am State Health Officer of the State of South Dakota.

MR. GRIMES: I am Joe Grimes, Chief Engineer and Water Resources Commissioner.

MR. HANTEN: My name is Robert Hanten, Fisheries Staff Specialist for the Game, Fish & Parks Department of South Dakota.

MR. STEIN: The parties to this conference according to Federal law, and that is what we are governed by in the calling of this, are the official State agencies and the Environmental Protection Agency. Participation in the conference will be open to representatives and invitees of these agencies and such persons as inform me they wish to present statements. However, only the representatives of the State agencies and the Environmental Protection Agency constitute the conferees.

Now a word about procedures governing the conduct of the conference. The conferees will be called upon to make statements. The conferees in addition may call upon participants whom they have invited to the conference to make statements, and other interested individuals who wish to make statements may present them. At the conclusion of each statement, the conferees will be given an opportunity to comment or ask questions and I may ask a question or two. This procedure has proven effective in the past in arriving at a description of the problem and an indication of where we have to go to get equitable solutions.

At the end of all the statements, we will have an executive session to which the conferees will be invited and try to arrive at a basis of agreement on the facts. Then we will have a public meeting again, attempt to summarize the conference orally, giving the conferees, of course, the right to amend or modify the summary.

Again let me call your attention to the procedures. We will not be taking questions or comments from the floor, but everyone will be given an opportunity to speak and if you just hold your questions or comments until your opportunity comes, you will be heard fully and no one will be cut off. We intend to give everyone a full hearing and listen to all pertinent information on the subject.

At the conclusion of the conference the Administrator is required by law to prepare a summary of it which will be sent to the conferees. The summary must include the following points:

Occurrence of pollution of interstate or navigable waters subject to abatement under the Federal Act;

Adequacy of measures taken toward abatement of pollution; and

The nature of delays, if any, being encountered in abating the pollution.

The Administrator is also required to make recommendations for remedial action if such recommendations are indicated.

A record and verbatim transcript of this conference is being made by Mrs. Virginia Rankin. This is being made for the purpose of aiding us in preparing a summary and also providing a complete record of what is said here. It usually takes about three or four months for the transcript to come out in printed form. If you wish a record beforehand, you can check with Mrs. Rankin, who is an independent contractor, and make your own arrangements with her for all or part of the transcript. I would like to indicate we do not print in color, so take that into account when you present charts, if you are going to do so. Try not to refer to color if you use graphic aides in your presentation as it may well be meaningless in the reading of the transcript.

We will make copies of the summary and transcript available to the official State agencies. We have generally found that for the purpose of maintaining relationships within the States the people who wish summaries of transcripts should request them through their State agency rather than come directly to the Federal Government. The reason for this is that when the conference has been concluded we would prefer people who are interested in the problem to follow the normal relationships in dealing with the State agencies rather than the Federal Government. This has worked successfully in the past and we will be most happy to make this material available for distribution.

I would suggest that all speakers and participants other than the conferees making statements come to the lectern and identify themselves for the purpose of the record.

We are going to follow the procedure of first calling on the Federal conferees and then on the State conferees. Each one of these conferees will manage his own time. The Federal conferee, as will be indicated, will just call on other Federal Agencies and Federal representatives. The State conferee, in addition to making its own statement, will call on industries and citizens within the State. If you wish to make a statement, you should make arrangements with the State conferee and the State will schedule you and indicate to you, as we get started and we are able to see our way more clearly through the Federal statements, as to the approximate time when you can expect to make a statement.

With that we will call on Mr. Dickstein for the Federal Government.

IRWIN L. DICKSTEIN

ENFORCEMENT DIVISION

REGION VIII, EPA, DENVER, COLORADO

MR. DICKSTEIN: Chairman Stein, fellow conferees, ladies and gentlemen. Prior to introducing several technical reports, I would like to make the following comments.

I wish to express at this time my sincere thanks to Dr. Hayes, Mr. Charles Carl and his staff, the staff of the South Dakota Department of Health, who cooperated to the fullest extent in the technical studies. And a special thanks to Mr. Marv Allum. The technical studies could not have been completed without the assistance provided by the South Dakota Department of Health.

A special thanks to Mr. Fred June of the Bureau of Sport Fisheries and his staff.

I furthermore wish to acknowledge the Homestake Mining Company of Lead, South Dakota, and the Mines Development Company of Edgemont, South Dakota, who gave their full cooperation in this study. Both companies have provided the field teams with access to the mill property and when necessary provided space to conduct various tests. Information of a technical nature was provided to the technical staff of EPA and the State without any hesitation, thus illustrating pollution control agencies and industry can work together in solving their mutual problems.

Let's now proceed with the Federal technical presentation.

First of all I would like to present Mr. Richard Warner of the Division of Field Investigations, Office of Enforcement, Denver Center, EPA.

Mr. Warner.

RICHARD W. WARNER, AQUATIC BIOLOGIST
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DENVER, COLORADO

MR. WARNER: Mr. Chairman, conferees, and ladies and gentlemen.

My name is Richard W. Warner and I am an aquatic biologist with the Environmental Protection Agency National Field Investigation Center, Denver, Colorado.

I wish to read portions of a report entitled "Pollution Affecting Water Quality of the Cheyenne River System, Western South Dakota." I provided a copy of the report to the recorder and request that it be entered in the record as if read.

MR. STEIN: Without objection, this will be done.

(The above-mentioned report follows:)

ENVIRONMENTAL PROTECTION AGENCY
OFFICE OF ENFORCEMENT

Report on
POLLUTION AFFECTING WATER QUALITY
OF
THE CHEYENNE RIVER SYSTEM
WESTERN SOUTH DAKOTA

Division of Field Investigations - Denver Center
Denver, Colorado

Region VII
Kansas City, Missouri

Region VIII
Denver, Colorado

September 1971

ADDENDUM TO REPORT ON POLLUTION AFFECTING WATER QUALITY OF THE CHEYENNE RIVER SYSTEM, WESTERN SOUTH DAKOTA

On page 2, end of last paragraph, add -- The cooperation and support of various Federal, State and private agencies is gratefully acknowledged.

Page 3, 5th line from bottom, change 2.5 to 2.35.

Page 4, 5th line after "Whitewood Creek" insert -- The suspended solids discharge is approximately 375 times greater than the load permitted under the applicable water quality criteria, at a streamflow of 30 cfs.

Page 15, line 7 after "mercury" insert -- with concentrations as high as 124 micrograms per liter.

Page 15, line 11 after "agreed" add -- and discontinued use of mercury amalgamation in December 1970.

Page 15, 3d line from bottom after "fish samples" add -- or 3.8 percent of the analyses.

Page 15, 2d line from bottom after "fish samples" add -- or 15.2 percent of the analyses.

Page 18, 2d line from the bottom, change to read -- known to inhabit the study area but may not be harmful to insect larvae

Page 21, at top, add -- Elk Creek heads in the Black Hills just south of the Lead-Deadwood area. It flows east, passing into the plains just north of Rapid City. From this point to the mouth, Elk Creek flows over deposits of marine shales. A water sample collected during June contained 2.0 µg/l of mercury, or a load of 1.2 lbs/day. This was the highest concentration of mercury observed in any steam not influenced by Homestake discharges, and resulted from leaching of mercury adhering to suspended sediment particles. Subsequent water samples collected during July did not contain detectable mercury. The benthos community of Elk Creek reflected the influence of domestic waste or agricultural drainage and intermitten flows; however, the flesh of fish collected from this stream contained only 0.05 ppm of mercury.

Page 23, 3d line from bottom, change "1.5 micrograms per liter" to "1.4 micrograms per liter."

Page 25, 2d paragraph, 6th line after "arsenopyrite" insert sentences -- The suspended solids concentrations in Whitewood Creek, according to applicable stream standards, should be less than 90 mg/l. This indicates that the maximum allowable load of suspended solids in Whitewood Creek from all natural and artificial inputs can be no greater than 7.3 tons per day at a flow of 30 cubic feet per second. Therefore, the discharge of Homestake Mining Company effluent is approximately 375 times greater than the maximum permitted solids load in Whitewood Creek at 30 cfs. To meet existing standards, there must be a reduction of at least 99.7 percent of the present solids discharge from the Homestake Mining Company.

Page 29, 4th line, delete "during this study" and substitute "in the Cheyenne River system outside of Oahe Reservoir."

Page 30, after second paragraph, insert new paragraph -- A mineral of the amphibole group was common at all stream stations downstream of the Homestake discharge, but was not found at those stations upstream of the Homestake discharges. It was common in the deposits of buried tailings. The amphibole was also observed in sediment from the Cheyenne River arm of Oahe Reservoir. Optical mineralogy techniques were utilized to determine that the amphibole was the mineral cummingtonite, which is reported to be a major constituent of the Homestake ore.

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I. INTRODUCTION

During the summer of 1970, the U. S. Food and Drug Administration (FDA) analyzed fish from the Cheyenne River Arm of Oahe Reservoir, and other areas throughout western South Dakota. They found that mercury in the flesh of many fish in the Cheyenne Arm exceeded the FDA guideline of 0.5 parts per million (ppm). Fish from other areas, notably Angostura and Belle Fourche Reservoirs, contained some mercury, but generally at levels less than the FDA guideline.

Since the latter part of the nineteenth century, mercury had been used for gold recovery at the Homestake Mining Company Lead-Deadwood mill. Examination of published and unpublished information also led to the belief that other mining activities in the Black Hills previously had discharged mercury. Various State and Federal authorities have speculated that natural deposits of mercury minerals in the Black Hills and in marine shales throughout western South Dakota may cause mercury pollution.

Sampling in 1970 by the Environmental Protection Agency (EPA) revealed that Homestake Mining Company was discharging from twelve to forty pounds per day of mercury in their tailings slurry releases to Whitewood Creek, a tributary of the Cheyenne River system. The company discontinued the use of mercury in December 1970. Subsequent sampling revealed that the company was discharging cyanide, arsenic, and other toxic materials, together with vast quantities of suspended solids.

The Governor of South Dakota, by letter of April 23, 1971 (Appendix A) under Section 10(d)(1) of the Federal Water Pollution Control Act, requested that the Administrator of the U. S. Environmental Protection Agency call a conference of State and Federal agencies, to consider the occurrence, distribution, and significance of cyanide, mercury, and other metals pollution in western South Dakota.

This report presents the results of technical studies conducted in the Cheyenne River system by the Division of Field Investigations - Denver Center (DFI-DC), Office of Enforcement, EPA.

Objectives of these studies were:

1. To investigate the effects of natural mercury deposits throughout the Cheyenne River system in western South Dakota.
2. To determine the location and extent of reservoirs of mercury and other toxic materials due to previous mining activity, and measure the effect of the toxic substances on surface water, ground water, and biota.
3. To document and characterize the discharge of tailings solids and various dissolved toxic pollutants from the Homestake Mining Company Deadwood-Lead mill.
4. To ascertain the movement and fate of these pollutants in the hydrologic environment, and the effect of these pollutants on the biota.

To meet these objectives, data gathered by State and Federal agencies, universities, and companies were utilized. Special studies of biota, surface streams, ground water and sediment were also conducted.

II. SUMMARY AND CONCLUSIONS

1. Streams draining areas of placer mining and mineral deposits in the Black Hills do not contain significant concentrations of mercury or arsenic during normal runoff. Certain of the streams examined contained high concentrations of mercury during infrequent periods of high runoff. Fish in these streams contain mercury at concentrations less than the FDA guideline of 0.5 ppm. Streams draining areas of marine shale contain detectable quantities of mercury during infrequent periods of high runoff, but do not contain detectable mercury during normal stream flow. Fish in these streams contain mercury at levels generally less than the FDA guideline of 0.5 ppm.
2. The benthos communities of Spearfish Creek, Redwater River, Belle Fourche River at Fruitdale, Cheyenne River at Wasta and French, Battle, Rapid and Elk Creeks were not damaged by siltation or toxic materials. The flesh of fish collected from all of these stream reaches, with the exception of Redwater River, contained mercury at concentrations less than the FDA guideline. Redwater River carp contained mercury in excess of FDA standards.
3. Although Homestake Mining Company discontinued the use of mercury in their milling process in December, 1970, the plant effluents still contain approximately 2.5[*] pounds per day of mercury. This results from the leaching of mercury contained in the ore fed to the Homestake mill. A major portion of the discharged mercury is adsorbed by sediment in Whitewood Creek. From 0.1 to 0.5 pounds per day of mercury is transported into the Belle Fourche River during periods of low flow.

[*] See correction page 154.

Larger amounts are transported during high stream flows.

4. Analyses of effluents discharged during June, 1971, showed the Homestake Mining Company to be adding daily loads of 312 pounds of cyanide, 240 pounds of zinc, 72 pounds of copper, and 2735 tons of suspended solids to Whitewood Creek. The tailings solids include a load of 9.5 tons per day of arsenic in the form of arsenopyrite, an arsenic-iron sulfide. The arsenopyrite is oxidized, resulting in arsenic concentrations in the Cheyenne River which are four times greater than the U. S. Public Health Service water-supply criterion.

5. Whitewood and Deadwood Creeks, upstream from the Homestake discharges, contain high levels of mercury during runoff periods, but lower levels at other times. Flesh of fish from these streams does not contain detectable mercury concentrations. Deadwood and City Creeks, as well as Whitewood Creek upstream from Gold Run, were inhabited by diverse communities of aquatic organisms, including a predominance of forms sensitive to pollution. Whitewood Creek from Gold Run downstream to the mouth was severely damaged by discharges from Homestake Mining Company. No aquatic organisms were found in this stream reach. Concentrations of cyanide, arsenic, mercury, and suspended solids were each sufficiently high, independently or in concert, to damage the biota of Whitewood Creek. Damage extended into the Belle Fourche River downstream from the mouth of Whitewood Creek. Siltation and high arsenic concentrations in the Belle Fourche reduced the numbers and variety of benthos. Fish from this reach of the river contained high mercury concentrations.

6. Previously-discharged Homestake tailings solids have been deposited

along Whitewood Creek and the Belle Fourche and Cheyenne Rivers. These solids are eroded and leached during high stream flows. Buried deposits of tailings solids occur in abandoned river meanders, chiefly along the Belle Fourche River. Leaching of mercury from such deposits contaminates ground water, as well as surface streams. The ground water is used as a supply for domestic wells. Large quantities of mercury are contained in the buried tailings, and may be leached by ground water. After cessation of the discharge of solids from Homestake, the deposits will be eroded by surface streams as the streams adjust to a new hydrologic regime. Research is currently underway to develop methods of recovering mercury from sediments. The buried tailings also contain large quantities of arsenopyrite which may be leached to surface streams or ground water.

7. Deposits of Homestake Mining Company tailings occur in the Cheyenne River Arm of Oahe Reservoir. Mercury from these deposits contaminates the flesh of fish in the Cheyenne River Arm of Oahe Reservoir at levels often exceeding the FDA guideline.
8. Plans are underway for construction by the Lead-Deadwood Sanitary District of a tailings pond-sewage lagoon which will treat raw sewage from Lead and Deadwood as well as the Homestake Mining Company effluents. The facility is scheduled for completion in November 1973.
9. Interim tailings-pond sites are available which would result in a reduction of about 80 percent of the pollution carried by Whitewood Creek, pending completion of the Sanitary District facilities.

III. RECOMMENDATIONS

It is recommended that:

1. The Lead-Deadwood Sanitary District proposed treatment facility at Centennial Valley, for domestic sewage and Homestake tailings, be constructed and in operation by November 1973. Progress schedules as specified by the Refuse Act Permit Application are to be met.
2. Pending completion of the Sanitary District facility, Homestake Mining Company construct and operate an interim tailings pond, to control the continuing mercury pollution from Homestake, and substantially reduce the cyanide, arsenic, and tailings solids in Whitewood Creek. If the interim facility is not completed and operating by July 1, 1972, Homestake be cited under the provisions of the Rivers and Harbors Act of 1899, for discharging toxic materials and solids to the Cheyenne River system.
3. The location and composition of buried tailings materials along Whitewood Creek, the Belle Fourche River, and the Cheyenne River be carefully ascertained and fully documented. Toxic materials be recovered as the technology becomes available. Pending the development of recovery techniques, the deposits be contained to prevent their reentry into the hydrologic system.
4. Arsenic concentrations in wells drawing water from alluvium downstream of the Homestake discharges be determined, to ascertain whether these sources are acceptable for domestic or agricultural water supply uses.
5. The South Dakota Department of Game, Fish, and Parks assure that the excessive concentrations of mercury in fish of the Cheyenne River

system are known to the public, such notification to include recommendations of non-consumption of fish. Commercial fishing in the Cheyenne Arm of Oahe Reservoir should be prohibited.

6. A complete inventory of the location and composition of abandoned tailings piles in the area north and west of Lead be conducted by the State of South Dakota. The State take appropriate measures to assure that adverse effects on water quality and aquatic life resulting from residual toxic materials contained in these tailings shall not occur. The State assure that the tailings are controlled in accordance with the best available technology.

7. Water quality standards be established for Whitewood Creek and Deadwood Creek, including an implementation plan for abatement of existing pollution.

IV. DESCRIPTION OF AREA

A. PHYSICAL DESCRIPTION

The Black Hills are the dominant physical feature of western South Dakota, extending for approximately 50 miles in the north-south direction and approximately 30 miles in the east-west direction. The mountain crests have an average elevation of approximately 6,000 feet, with isolated peaks exceeding 7,000 feet. Headwaters of most major western South Dakota streams rise in the Black Hills.

B. CLIMATE

Precipitation throughout western South Dakota is closely related to elevation. The high areas of the Black Hills receive an annual precipitation of more than 20 inches per year while the plains areas receive less than 15 inches per year. Precipitation occurs both in the form of winter snows and early summer thunder storms. Lake evaporation is approximately 40 inches per year.

C. GEOLOGY

The Black Hills uplift is the dominant geologic feature of western South Dakota. The elliptical dome has influenced the outcrop and dip of strata in an area approximately 125 by 60 miles. Crystalline rocks of pre-Cambrian age are exposed in the central portion of the Black Hills. These rocks are more resistant to erosion than surrounding rocks. This results in higher elevations, and hence greater rainfall and runoff than from surrounding plains areas. The pre-Cambrian rocks have been extensively fractured and mineralized by subsequent intrusions. The mineralization includes arsenopyrite, an iron-arsenic sulfide; and cinnabar, mercuric sulfide.

Younger sedimentary strata dip radially away from the uplift, with formation outcrops in the form of concentric bands around the Black Hills, and are progressively younger with increasing distance from the dome. The sediments consist of limestones, sandstones, and shales. Some of the limestones and sandstones are regionally important aquifers. Several of the limestones contain solution cavities, which permit uninhibited movement of water.

Outside the Black Hills region, western South Dakota is underlain by Cretaceous and Tertiary shales, largely flat-lying. These were deposited under marine and lacustrine conditions, and contain numerous soluble salts. Such shales were suspected by South Dakota officials as sources of natural mercury pollution.

D. HYDROLOGY

Most of western South Dakota is drained by the Cheyenne River and its tributaries, the chief of which is the Belle Fourche River. Both of these streams head in northeastern Wyoming, in an area of Tertiary shales and sandstones. They then flow around the Black Hills uplift, with the Cheyenne River passing to the south and the Belle Fourche River skirting the north end. Several streams drain from the Black Hills to join the rivers on the uplift margin. The drainage pattern of western South Dakota, shown in Figure 1 at the back of this report, is thus greatly modified by the more-resistant rocks exposed in the Black Hills.

Spring, French, Rapid, and Battle Creeks drain the southern Black Hills, in the vicinity of Custer, Hill City, and Silver City. Much of the early mining took place in this region, with resultant disruption of the stream beds. Available information indicates that mercury was not widely used in this early mining.

Whitewood and Deadwood Creeks join in Deadwood at a point approximately 30 miles upstream of the confluence with the Belle Fourche River. The natural flow in both streams is minor except during runoff periods. The flow is augmented by the waste discharge from the Homestake sand dams and slime plant, and by the raw sewage discharge from Lead and Deadwood.

Ground water is available in western South Dakota from two sources: alluvium in bedrock valleys cut by surface streams, and consolidated aquifers which dip radially away from the Black Hills. The alluvial valleys are locally important as a source of supply for ranches along the streams, and are recharged by surface stream flow. The consolidated aquifers, sandstones and limestones, are regionally important as sources of supply, although the water is highly mineralized at points remote from outcrops of the various aquifers.

V. WASTE SOURCES

Mining of placer and lode gold deposits has occurred over much of the Black Hills region. In his letter requesting the western South Dakota pollution conference, Governor Kneip voiced concern over pollution resulting from past mining activities. Such pollution could include particulates eroded from old tailings piles, acids and metals from sulfide oxidation, and mercury from placer dredging and hard-rock milling.

Several inactive mill tailings piles, located west of Lead, were observed to be eroding during surface runoff events. Such runoff carries mineral-laden sediment into the water courses, for subsequent leaching, and could be a source of water-quality degradation.

Prior to the end of 1970, all gold recovery from lode mines in the Lead-Deadwood area involved use of mercury for gold amalgamation. First milling was by use of an arrastra, followed by the advent of stamp mills. The Homestake Mining Company batch process was developed around the turn of the century. In it, amalgamation plates were used to recover large gold particles. The ground rock was then separated into sand and slime fractions, for subsequent cyanide leaching to recover fine gold particles. After the gold was leached from the ore, the spent rock was sluiced from the plant. Formerly, all the solids were discharged into Whitewood Creek. In recent years, Homestake Mining Company has returned approximately 80 percent of the sand fraction to the mine, to prevent subsidence. Due to the bulking effect which results during grinding of the ore, all the ground rock cannot be replaced in the mined spaces. Therefore, the remaining 20 percent of the sand fraction, and all the slime fraction, is sluiced directly into Whitewood Creek. Under present production levels, this results in a 2,735 ton per day discharge of suspended solids to Whitewood Creek. This material consists of finely-ground particles containing arsenopyrite, an arsenic-iron sulfide, and other sulfide minerals. The water solution used in sluicing the solids from the plant contains residual cyanide used in ore leaching. The liquid and solid material contained mercury lost from the amalgamation plates.

After mercury was recognized as a serious pollutant, officials of Homestake Mining Company agreed to discontinue use of amalgamation as a gold-recovery method, and to rely on the use of cyanide leaching for all gold recovery. This change was achieved early in 1971. Currently, the sand and slime fractions are treated in a series of cyanide washes and rinses, with gold recovery achieved by zinc-dust precipitation. Barren rock and cyanide are still sluiced directly into Whitewood Creek, and affect water quality in the Belle Fourche and Cheyenne Rivers.

Deposits of previously-discharged tailings solids buried in active streams and abandoned meanders constitute a continuing source of toxic materials to surface streams of western South Dakota, and may pollute nearby ground water.

The towns of Lead and Deadwood have only rudimentary sewage-treatment facilities. Collection systems are old, and carry storm runoff, infiltration, and sanitary sewage. Most of the sewage from Lead and Deadwood is discharged directly to Whitewood Creek, with no treatment.

VI. WATER QUALITY AND RELATED FACTORS

A. APPLICABLE STANDARDS

Water quality standards for surface waters of South Dakota were adopted by the South Dakota Committee on Water Pollution, February 16, 1967, and were subsequently approved by the Secretary of the Interior.

The standards, under general requirements, specify that no sewage or industrial waste shall be discharged which produces, among other effects, material discoloration, sludge deposits, or other offensive effects. The general provisions also prohibit the discharge of toxic materials which harm aquatic life.

The standards specify that the Belle Fourche and Cheyenne Rivers are for warm water semi-permanent fishery, limited contact recreation, wildlife propagation and stock watering, and irrigation. Numerical limits for several important constituents which apply for such uses are:

Cyanide, less than 0.02 mg/l
Iron, less than 0.2 mg/l
pH, 6.3 to 9.0
Suspended solids, less than 90 mg/l
Turbidity, less than 100 Jackson Turbidity Units

No numerical standards have been established for Whitewood Creek. Portions of the applicable stream standards are reproduced in Appendix B.

B. PREVIOUS STUDIES

The first known cognizance of pollution from the Homestake operation is contained in "South Dakota, A Guide to the State",[1] a WPA authors project book. In this publication, it is stated that "Whitewood Creek, once a crystal-clear tumbling mountain stream, now a dirty leaden color, literally a flow of liquid mud, caused by the tailings from the Homestake Mine at Lead, flows through the center of Deadwood. Livestock will drink the water along the lower reaches; but no animal life is possible in it."

An early study of the waste loads discharged by Homestake, and their effects on receiving streams, was carried out in June and July 1959, by the South Dakota Department of Health, with assistance from the U.S. Public Health Service. In two reports[2,3], published in 1960, the State Department of Health reported a discharge of 2400 tons per day of tailings solids and 133 pounds per day of cyanide to Whitewood Creek. One of these disclosed that the waste destroyed all life in Whitewood Creek and the first several miles of the Belle Fourche River downstream from the mouth of Whitewood Creek. Tables of stream data generated by the 1959 survey are reproduced from the 1960 reports in Appendix C. The data show that concentrations of cyanide in Whitewood Creek below the Homestake discharges ranged to over 2.10 mg/l. Cyanide was detectable in the Belle Fourche and Cheyenne Rivers, below the Whitewood Creek inflow.

A settling-tank study conducted in conjunction with the 1959 survey indicated that significant water quality improvement could be achieved by installation of a tailings pond. Accordingly, in the "Report on Gold Recovery Wastes," the State recommended that "Programming be initiated to exclude solids from the receiving stream."

By August 1970, no progress had been made in the Homestake waste-treatment practices and the tailings solids were still being discharged to Whitewood Creek. The discharges were found to contain significant quantities of mercury. Table 1 contains mercury data collected during the various stream sampling periods in 1970.

Following the discovery of high mercury levels in the streams, Homestake Mining Company was requested to discontinue use of mercury in its amalgamators. Homestake officials agreed, and removed all mercury from the milling cycle by January 1971. Samples were collected downstream of the Homestake Mill shortly after amalgamation was discontinued. High levels of mercury in the effluent indicated the presence of residual mercury in the milling equipment. The data contained in Table 2 show the continued presence of mercury in Whitewood Creek downstream of the Homestake discharges. Cyanide concentrations in Whitewood Creek were at levels considered harmful to fish[4/].

Flesh of fish from the Cheyenne River Arm of Oahe Reservoir was found to contain mercury at levels greater than the FDA guideline of 0.5 parts per million. Results of fish sampling throughout South Dakota during 1970 are summarized by South Dakota agencies (Appendix D). Only two fish samples from the areas not influenced by Homestake discharges exceed the FDA guideline of 0.5 ppm. Seven fish samples from the area influenced by Homestake discharges exceeded the FDA guideline.

TABLE 1

Mercury Concentrations in South Dakota Water Samples Collected During 1970

Location	1970 Date		Mercury Concentration (μg/l)
Whitewood Creek above Gold Run	7/14		<1.0
	8/13		<1.0
	11/14		<1.0
Deadwood Creek above its mouth	8/13		<1.0
Whitewood Creek at Deadwood	8/13-14	Comp.	100
	8/14-15	Comp.	Interference
	11/3-4	Comp.	68
	11/4	Comp.	80
Whitewood Creek one mile above its mouth	8/12		96
	11/4		124
Belle Fourche River above Whitewood Creek	7/16		<1.0
	8/12		<1.0
Belle Fourche River at Route 79 Bridge	8/12		16.5
Belle Fourche River at Route 34 Bridge	8/12		3.0
Belle Fourche River southeast of Hereford	8/12		3.0
Belle Fourche River at Elm Springs	8/12		2.6
Cheyenne River at Route 34 Bridge	8/12		1.8
Cheyenne River at Route 63 Bridge	8/12		1.1

TABLE 2

Mercury and Cyanide Concentrations in Stream Samples from Lead-Deadwood, S. D. January, 1971

Location	Mercury µg/l	Free CN mg/l	Total CN mg/l
Combined Discharges - Whitewood Creek at Rodeo Campground - Deadwood, South Dakota (Flow 13.2 cfs)			
Composite January 21, 1971 (1230 to 2300 hours)	12.	*	*
Composite January 22, 1971 (0001 to 1100 hours)	29.±7	2.6	3.65
South Dakota on Crook Mountain Road	39.	1.4	3.15
Whitewood Creek at Lawrence - Meade County Line	*	1.0	1.25
Whitewood Creek at Bridge near Confluence with Belle Fourche River	33.	0.5	1.15

* No analyses run

C. RECENT EVALUATIONS

Water samples were collected by EPA from streams in the Lead-Deadwood area during March and May, 1971, for mercury and cyanide analysis. Sampling of bottom sediments and core drilling of buried tailings deposits was accomplished during May. A major water quality and biological survey of western South Dakota streams was conducted during May, June and July, 1971. The May and June sampling was done during abnormally high stream flows and frequent rains, while the July sampling period was during a period of normal climatic conditions. Biological and water quality findings are summarized in Appendix E. Survey methodology is discussed in Appendix F. Sampling locations are shown in Figure 1 at the back of this report.

The pollutants discharged to the streams investigated during this survey may be separated into three categories, toxic material, inorganic sediment and organic wastes. The following discussion of toxicity is taken from McKee and Wolfe[4/], and from "The Study Group on Mercury Hazards"[5/]. Toxic materials include such pollutants as cyanide, arsenic, and mercury. Cyanide toxicity is affected by pH, dissolved oxygen, temperature, and minerals in solution. Game fish cannot tolerate 0.2 mg/l of cyanide for 96 hours and 1.0 mg/l will inhibit organisms that exert biochemical oxygen demand. Invertebrate organisms can tolerate no more than about 4.0 mg/l of cyanide in water. Arsenic in water is toxic in the range of 2 to 3 mg/l to some of the fish known to inhabit the study area and may be harmful* to insect larvae at 20 mg/l[4/]. The toxicity of mercury to aquatic biota depends upon

* See correction page 130.

its chemical state. Elemental mercury is relatively insoluble in water; therefore, aquatic organisms usually are not exposed to it in high concentrations. However, elemental mercury is readily methylated by microorganisms, and becomes quite water soluble. Methylated mercury compounds are readily taken up by aquatic organisms, and may be toxic or accumulative in the organisms. Thus, fish, exposed to minute mercury concentrations may accumulate it in their tissues to levels hazardous for human consumption. Mercury concentrations from 4 to 20 μg/l may be harmful to fish, while approximately 40 μg/l is harmful to invertebrates. The U. S. Food and Drug Administration recommends that fish containing 0.5 ppm mercury not be eaten.

The second category of pollutants is solid matter suspended in the water, primarily finely-ground and extremely dense mill tailings. These solids settle on stream bottoms, destroy habitats and smother aquatic organisms. The pollutional effect is deletion of organisms, and the result is difficult to distinguish from toxic effects.

The third category of pollutants, domestic and agricultural wastes, produce water quality conditions which tend to favor the growth of pollution tolerant organisms, to the exclusion of sensitive forms. The benthos often consist of sludgeworms, midge larvae, leeches, and snails rather than stonefly and mayfly nymphs. Fish populations are often represented by carp and suckers rather than game fish.

The following sections discuss by stream the water quality and biological conditions observed during the recent surveys.

Cheyenne River Drainage

A water sample collected from the Cheyenne River at Wasta, S.D. (Station 4235) during high runoff contained 0.4 μg/l of mercury, or 4.5 pounds of mercury per day. The sample did not contain detectable arsenic or significant quantities of other toxic metals. Mercury was not detected in samples collected in July, during normal streamflow. The mercury load in the June sampling resulted from leaching of mercury-bearing suspended sediment. A bottom sediment sample from the site contained only 0.04 ppm of mercury. This indicates that high mercury concentrations in the stream are not concommitant with normal stream flow.

Battle Creek (Station 4040) drains an area of previous mining activity, upstream of Hayward. A water sample from the creek contained 0.3 μg/l of mercury, or 0.07 pounds per day. Rapid Creek also drains an area of previous mining activity. A water sample collected from Rapid Creek below Pactola Dam (Station 4115) contained 0.2 μg/l of mercury, or 0.14 pounds per day. These findings indicate that previous mining sites are not significant mercury pollution sources.

Boxelder Creek heads in the Black Hills, flows by Ellsworth Air Force Base, and drains a large Cretaceous shale area. A water sample collected at Owanka (Station 4200.5) contained 0.6 μg/l mercury or 0.05 pounds per day of mercury. This concentration apparently resulted from leaching of shale washed into the stream during previous rainfalls. No detectable arsenic was found in the sample. Sediment from this station contained only 0.02 ppm of mercury, which indicates that mercury is not normally present in significant quantities in the stream.

The levels of mercury contained in the above streams during periods of runoff do not cause high mercury concentrations in resident fish. Fish collected from Angostura Reservoir (Station 4010), the Cheyenne River at Wasta (4235), and from tributaries, including French Creek (4025.5), Battle Creek (4060), Rapid Creek (4130), and Elk Creek (4255), all contained mercury concentrations less than half the FDA guideline. The biotic communities of each of these streams, except Rapid Creek, reflected the presence of organic wastes. No adverse effects of siltation or toxic substances were detected in any of the streams in this portion of the Cheyenne River drainage.

Nutrients made the Cheyenne River at Wasta and its upstream tributaries extremely fertile. This over-enrichment affected the aquatic life community. Benthos samples collected near Wasta contained high densities (764 per square foot) and low variety (10 kinds) of organisms. This reflected the presence of organic wastes and the absence of siltation or toxic materials.

Belle Fourche River Drainage

The farthest upstream station in the Belle Fourche River drainage system was located on Spearfish Creek downstream from Bridal Veil Falls, near Maurice (Station 4314.7). Here, the benthos consisted mostly of pollution-sensitive mayflies, caddisflies, and stoneflies, with large numbers of black fly larvae of intermediate tolerance, indicating little or no pollution. Two unfiltered water samples from this station, collected during a rainstorm, contained 0.5 and 2.3 μg/l of mercury. The wide variation in results indicates that the mercury was attached to sediment being washed into the stream, possibly from tailings piles located upstream along tributaries to Spearfish Creek. Brook trout and brown trout collected from this stream contained no detectable mercury, indicating that high mercury concentrations occur infrequently in Spearfish Creek.

The Redwater River (Station 4329.5), which receives drainage from Spearfish Creek, drains into the Belle Fourche River near Belle Fourche, South Dakota. The diversity of pollution-sensitive benthos indicated minimal damage from siltation or toxic materials. Trout collected here did not contain detectable mercury concentrations and the flesh of white suckers and creek chubs had mercury concentrations of less than 0.20 ppm. However, northern redhorse suckers collected from the Redwater River had moderate mercury concentrations in their flesh, averaging 0.29 ppm; and carp had unacceptably high mercury concentrations in their flesh, averaging 0.58 ppm. Apparently these fish migrated into the Redwater River from contaminated waters downstream.

Belle Fourche Reservoir (Station 4350) receives water diverted from the Belle Fourche River below the Redwater River confluence. Fish collected from this reservoir all contained mercury concentrations less than one-half the maximum limit recommended by FDA.

A water sample collected from the Belle Fourche River near Fruitdale (Station 4360), during the June period of high runoff, contained 0.4 μg/l of mercury. In subsequent samples, collected during normal streamflow, mercury was not detected. No arsenic was detected in the stream, even during periods of high streamflow. The Belle

Fourche River at this location (Station 4360) was biologically fertile, but not polluted. Benthos in this reach consisted of a variety (17 kinds) of primarily pollution-sensitive organisms, including burrowing mayflies, and low numbers of intermediate and tolerant forms. All fish collected from this river reach contained mercury concentrations less than 0.5 ppm. The highest mercury concentration detected was 0.29 ppm in one fish, a goldeye.

Whitewood Creek at the U. S. 85 bridge at Pluma (Station 4361) generally contained low levels of mercury. One sample, collected June 9, during a rainstorm, contained 1.7 μg/l of mercury, apparently the result of leaching from sediment washed into the stream. Arsenic was present in relatively low levels of 12 to 13 μg/l. Other metals were present as the result of the known mineralization in rocks upstream of this station. A sediment concentration of 0.54 ppm mercury is consistent with the mineralized nature of the drainage basin. The stream supported the greatest variety of benthic organisms encountered during the survey (26 kinds), including five stonefly genera, four mayfly and caddisfly genera, and many other forms in moderately high numbers. Fish collected from this reach (brook trout, white suckers, and longnose dace) did not contain detectable mercury concentrations.

Deadwood Creek above Deadwood (Station 4361.3) generally contained low levels of mercury. One sample, collected June 9, during a rainstorm, contained 1.5* μg/l of mercury, similar to levels in Whitewood Creek on the same day. These high levels result from erosion of sediment from the known mineralized area. During the three days

* See correction page 137.

of sampling in June, 1971, the stream carried an average mercury load of 0.04 pounds per day. Sediment contained 0.12 ppm mercury. Arsenic was present in low concentrations of 8 to 12 µg/l. Other metals were present in levels slightly higher than those in Whitewood Creek. The stream supported a diverse assemblage of 23 kinds of benthic animals, including many pollution-sensitive forms. Brook trout collected from Deadwood Creek contained no detectable mercury.

The quality of City Creek at Deadwood (Station 4361.4) was similar to that of Deadwood Creek and Whitewood Creek. Metals were present, but did not appear to harm the stream biota. Qualitative biological sampling of City Creek revealed the presence of many pollution-sensitive forms.

Flow in Gold Run (Station 4361.1) consisted of discharge from the Homestake Mining Company's sand dams, and sewage from the town of Lead. The stream contained extremely high concentrations of suspended sediment. Mercury concentrations in the water ranged from 3.8 to 12.0 µg/l. Cyanide was present at levels of from 0.5 to 3.6 mg/l. Arsenic levels of 138 to 1000 µg/l were present in the stream, as a result of oxidation of the vast amounts of arsenopyrite in the Homestake tailings slurry. The stream contained 0.39 mg/l of copper and 1.15 mg/l of zinc in one sample. No aquatic organisms inhabited Gold Run. The concentrations of cyanide, mercury, arsenic, and suspended solids detected in this reach were each sufficiently great to be independently destructive to fish and benthos. Therefore, it was not possible to attribute the destruction of aquatic biota to a single constituent contained in the Homestake Gold Mill effluent -- all were damaging.

The Homestake Mining Company slime plant effluent is discharged into Whitewood Creek immediately upstream from Deadwood Creek. Mercury in this effluent ranged to concentrations as high as 57 μg/l, as the result of leaching of mercury from the ore fed to the mill. No mercury was used in the process at the time. Cyanide, used in the leaching process, was escaping in the sluiced waste, at concentrations of from 3.8 to 9.9 mg/l. Arsenic was abundant in the effluent samples, with concentrations ranging to 1,000 μg/l.

Whitewood Creek, at the Deadwood Rodeo Grounds (Station 4361.5) was in marked contrast to the quality of the stream upstream from Gold Run, and to Deadwood and City Creeks. The creek was a leaden-gray stream of sand and slimes, resulting from the discharge in the two Homestake effluents of 2,735 tons per day of suspended solids, containing 9.5 tons per day of arsenic in the form of arsenopyrite. Mercury concentrations ranged from 2.1 to 8.0 μg/l, for an average mercury load during the June sampling of 2.5 pounds per day. Tributary flow added 0.15 pounds per day of this total load, with the remainder contributed by the leaching of mercury contained in the ore fed to the Homestake Mill. Additional mercury remains attached to the sediment discharged to the stream, but is available for leaching during high stages and for methylation and uptake by downstream biota. Cyanide concentrations in Whitewood Creek at the Deadwood Rodeo Grounds ranged from 0.50 to 1.1 mg/l, for an average load of 312 pounds per day during the June sampling. All the cyanide was from the Homestake mill. Arsenic was present in the water at concentrations of from 230 to 1700 μg/l. The stream carried a load of 72 pounds per day of copper and 241 pounds per day of zinc on June 10, 1971. Of this, less than 0.6 pounds per day of copper and 4 pounds per day of zinc were contributed by tributary inflow. The remainder was from the Homestake effluents. No aquatic organisms inhabited this station, as the result of the high concentrations of cyanide, mercury, arsenic, and suspended solids.

Stream sediment contained 0.18 ppm of mercury, which is approximately one-third of the concentration of 0.57 ppm of mercury in the ore fed to the Homestake Mill. The remainder of the mercury is leached from the ore during the milling process.

Water-quality conditions in Whitewood Creek at downstream stations (Stations 4361.6 and 4361.7) did not improve materially. Mercury concentrations remained high, although the load decreased as the result of adsorption on the tailings solids. Arsenic concentrations increased downstream to a range of 1270 to 1900 μg/l at the mouth. Cyanide concentrations were 0.58 mg/l downstream from Whitewood, and 0.16 mg/l at the mouth, near Vale. Copper, iron, and zinc were present. The stream supported no aquatic life downstream from the Homestake discharges. The destruction of all life in this stream is directly attributable to the high concentrations of cyanide, mercury, arsenic, and suspended solids resulting from the two Homestake discharges.

Horse Creek (Station 4368) and Bear Butte Creek (Station 4375) are the major tributaries to the Belle Fourche River in the vicinity of the mouth of Whitewood Creek. Water samples collected from these two streams during June contained low mercury concentrations, apparently as the result of leaching of decomposed shale washed into the stream. Neither sample contained detectable arsenic concentrations. Samples collected during July, at normal streamflow, did not contain detectable mercury concentrations.

The effects of the Whitewood Creek inflow were evident in the Belle Fourche River at Station 4370. Suspended sediment, resembling Homestake tailings, was clearly visible in the water, with a large amount of settled solids covering the stream bottom. Mercury concentrations in the stream during June were 0.6 μg/l, or 3.0 pounds per day. The arsenic concentration was approximately 0.5 mg/l. Arsenic levels were sufficiently high to be a source of chronic toxicity to aquatic organisms. The cyanide concentration was less than the detection limit of 0.02 mg/l. Suspended solids settled on the river bottom, destroying habitat. The benthos in this reach consisted of little variety (6 kinds) of organisms in a very low density of only 30 per square foot. The flesh of fish collected from this reach contained moderate-to-high concentrations of mercury, some of them bordering on 0.5 ppm.

Water samples were collected from the Belle Fourche River north of Elm Springs, Station 4380. As previously noted, the June sampling was conducted during a period of high, but declining, stream stages. Flow time between the Stations 4370 and 4380 was estimated at one day.

As a result, the net flow measured at the downstream station was much larger than the flow at the upstream station. This higher flow was responsible for the resuspension of previously-deposited Homestake tailings solids. A portion of the metals concentration contained in these tailings solids was leached into the stream, resulting in an increase in metals load in the downstream direction. The June samples at Station 4380 contained 2.8 µg/l of mercury, or 19.7 pounds per day, in contrast to the load of 3.0 pounds per day at the upstream station, Station 4370. This instream increase in mercury load, attributable to the resuspension of tailings, indicated the importance of removing mercury-laden tailings solids from the streambed and banks. Otherwise, the material will continue to be a source of mercury for years. The zinc concentration at Station 4380, north of Elm Springs, was double that at Station 4370, and also resulted from resuspension of the previously-deposited Homestake tailings solids.

Lower Cheyenne River Drainage

Water samples collected in June from the Cheyenne River downstream from Belle Fourche River contained 0.5 µg/l of mercury, or 15.1 pounds per day. Arsenic levels were approximately 0.2 mg/l, or four times the level which constitutes grounds for rejection as a domestic water supply. Thus, the Homestake discharges render the entire stream unsuitable as a source of domestic water supply. Samples collected during July, during normal streamflow, did not contain detectable mercury in solution. A moderate degree of siltation had occurred in the Cheyenne River at Station 4385, near Plainview. Here, the benthic types were similar to those at Wasta, but the density of organisms decreased by 75 percent. Some of the fish collected at Station 4385 were heavily contaminated with mercury. Sauger flesh had a mercury concentration of 0.82 ppm, the highest encountered during this study. Carp and channel catfish were also contaminated by high mercury concentrations.

A sediment sample from Station 4385 contained 0.83 ppm of mercury. This concentration reflects the previous use of mercury in the Homestake amalgamators and is indicative of the deposition and resuspension which occurs in the travel of tailings from Lead-Deadwood to Oahe Reservoir.

Samples of fish collected from the Cheyenne Arm of Oahe Reservoir by the U.S. Fish and Wildlife Service and analyzed by EPA personnel generally contained high mercury concentrations, many of which exceeded the guideline. Results of this sampling are reproduced in Appendix E, Table E-5. Mercury concentrations exceeding 0.5 ppm, were detected in the flesh of northern pike, walleye, sauger, white bass, black crappie, channel catfish, freshwater drum, shovelnose sturgeon, carpsucker, carp, and bigmouth buffalo. Mercury concentrations in fish flesh were highest in the upper Cheyenne Arm of Oahe Reservoir, near the River mouth, with over 25 percent of all samples exceeding the guideline. Mercury concentrations in fish flesh generally decreased with distance from the River mouth. Mercury was not detected in water samples collected from the Cheyenne Arm, but bottom muds contained excessive mercury. The mercury concentrations in muds were highest in the upper Cheyenne Arm near the Cheyenne River mouth, with generally decreasing concentrations toward the main reservoir body. The levels were highest in mid-channel and lower near shore. This indicates that mercury-laden sediment continues to be transported into Oahe Reservoir by high streamflow in the Cheyenne River. The sediment then deposits in Oahe Reservoir and contaminates fish.

D. TAILINGS DEPOSITS

Calculations indicate that at least 65 million tons of tailings solids have been discharged by the Homestake Mining Company during the history of the Company's Deadwood-Lead operation. At least nine million tons of tailings have been discharged since the completion of Oahe Reservoir. The discharge of this sediment has completely changed the hydrologic regime of the Whitewood Creek-Belle Fourche River-Cheyenne River system. Much of the material was deposited along the various streams, especially the lower reaches of Whitewood Creek and the Belle Fourche River in the first few miles below the mouth of Whitewood Creek.

A limited amount of core drilling was performed, to verify the presence of deposits of previously-discharged Homestake tailings. In one case, drilling in an abandoned stream meander seven miles east of Vale, disclosed that old Homestake tailings had been deposited, causing the stream to change its course. The meander contained up to nine feet of tailings at the holes drilled, for an estimated total volume of 30,000 cubic yards of tailings deposits. Assay of the buried material indicated that this deposit contains approximately

200 pounds of mercury. Several other abandoned meanders were observed in the same area. Representative logs of drill holes in the tailings deposits, with the concentrations of mercury in the material, are presented in Appendix E, Table E-8.

In lower reaches of Whitewood Creek, the flood plain is underlain by up to 10 feet of material which appears to be stamp-mill tailings, deposited during the early milling days in the Lead area. A sample was found to contain 1.2 ppm of mercury. If this is representative, each cubic yard would contain 1.6 grams of mercury. At the bridge downstream from Crow Creek, these deposits extend for at least one-quarter of a mile along the stream, with an average width of 100 yards. This section may contain 290 pounds of mercury.

Ground-water samples were collected from auger holes in the tailings deposits, and from nearby wells drawing water from the alluvium. Solids samples were collected from the auger holes, at various depths. Solids assay results are shown in Appendix E, Table E-8. Ground-water quality data are shown in Appendix E, Table E-9. The buried tailings solids contain mercury in concentrations of from two to four parts per million by weight. Those solids beneath the water table generally contain less mercury than those above the water table, indicating a leaching of mercury by ground water has occurred and is continuing. This conclusion is supported by data on mercury concentrations in the ground water. A sample of ground water from the tailings deposit contained 34 μg/l of mercury, nearly seven times the recommended PHS limit of 5 μg/l for drinking water. A sample of ground water from alluvium underlying the tailings solids contained 1.8 µg/l, which is more than background mercury levels of 0.2 to 0.3 µg/l. Water samples from some wells along the stream contain mercury at levels exceeding background concentrations, but less than 5 µg/l. These concentrations correlate with distance from the stream and buried tailings deposits.

Samples from four domestic water supply wells, which draw water from the alluvium along the streams, were analyzed for arsenic. No arsenic was detected, indicating that arsenopyrite in the buried tailings is not being leached to the ground water.

While the concentrations of mercury in the ground water are generally less than the proposed PHS standard, they do indicate a continuing degradation of quality as a result of the buried tailings solids. Ground-water conditions are such that mercury from these deposits will continue to enter the surface streams via ground-water inflow.

The deposits of buried tailings solids are of importance to future water quality. The rivers are eroding the deposited material. Thus, the deposits will gradually be moved downstream to Oahe Reservoir. This effect will be accelerated once discharge of solids from Homestake has ceased. At that time the affected streams will initiate a period of downcutting, to adjust to a new set of hydrologic conditions. The buried tailings deposits will continue to be a source of sediment and metals pollution, unless they are removed or stabilized.

Additional information is required on the location, extent, and composition of the buried deposits. The needed information can be secured by a combination of remote-sensing technology and an exploratory drilling program.

Presently research is in progress to develop techniques for recovery of mercury from sediments. If the techniques prove feasible, they should be employed to recover the mercury contained in the buried tailings deposits. If the techniques are infeasible the deposits should be stabilized, pending later technical developments.

VII. WATER POLLUTION CONTROL ALTERNATIVES

A Sanitary District has been formed to abate pollution from the discharge of sewage from the towns of Lead and Deadwood, and the Homestake Mining Company discharges. A system has been designed to collect the Homestake wastes and the sewage, and transport it via pipeline to a large tailings pond-oxidation lagoon to be constructed in Centennial Valley. An application for a construction grant was submitted to the Environmental Protection Agency on April 8, 1971. The schedule of construction calls for completion of the facility by November 1973.

There has been much local opposition to the project, on the basis of damage to scenic values and ground-water resources. The project will visually degrade the valley site. However, the overall environmental impact will be less than the existing situation, for miles of stream are rendered gray and lifeless and a health hazard exists. The planned facility should not damage the ground-water resource. The proposed Sanitary District project will be a marked improvement over the existing situation.

The present health hazard resulting from toxic materials in the Homestake effluent must be abated. Personnel of Homestake Mining Company and EPA investigated alternative techniques which could be utilized for an interim pollution-control measure. Primary considerations in the selection of interim control measures were rapidity of construction and control of sediment discharge.

Whitewood Creek flow is highly variable, with known discharges in excess of 5,000 cfs. During 8 months of the year the flow is less than 30 cfs, and consists largely of sewage from Lead and Deadwood and of

Homestake Mining Company tailings slurries. Substantial water-quality improvement would result from construction of a system to divert and impound the Whitewood Creek flow, especially when such flow is less than or equal to 30 cfs. Higher flows could continue downstream with relatively little effect.

A suitable diversion site is available on Whitewood Creek downstream from the town of Whitewood. Crow Creek, a small intermittent stream, almost intersects Whitewood Creek before turning and flowing parallel to Whitewood Creek (Figure 2). A small diversion canal could be constructed through the intervening ridge, and a simple diversion dam constructed across Whitewood Creek. Flows less than 30 cfs would then be diverted to Crow Creek and the tailings solids settled in an impoundment. Clarified water would overflow the impoundment, continue down Crow Creek, and rejoin Whitewood Creek. Flows in excess of 30 cfs would overflow this diversion dam and travel down Whitewood Creek. The proposed project would remove approximately 80 percent of the pollutants carried by Whitewood Creek currently. The project, as envisioned, would be of simple construction and could be completed in a short time. Following completion of a permanent treatment facility it will be necessary to stabilize the impounded tailings in the temporary facility, to prevent erosion to Lower Crow Creek and the downstream waterways.

Homestake Mining Company reports encountering inflated land prices in their discussions with land owners in the Crow Creek area. Because the Company does not have the right of condemnation, the practice of asking inflated prices for land in the project area threatens the establishment of the interim tailings pond which will significantly reduce the existing health hazard caused by Homestake's discharge. The Crow Creek diversion and tailings pond is a necessary and technically feasible interim-control measure pending the completion of the Sanitary District facilities.

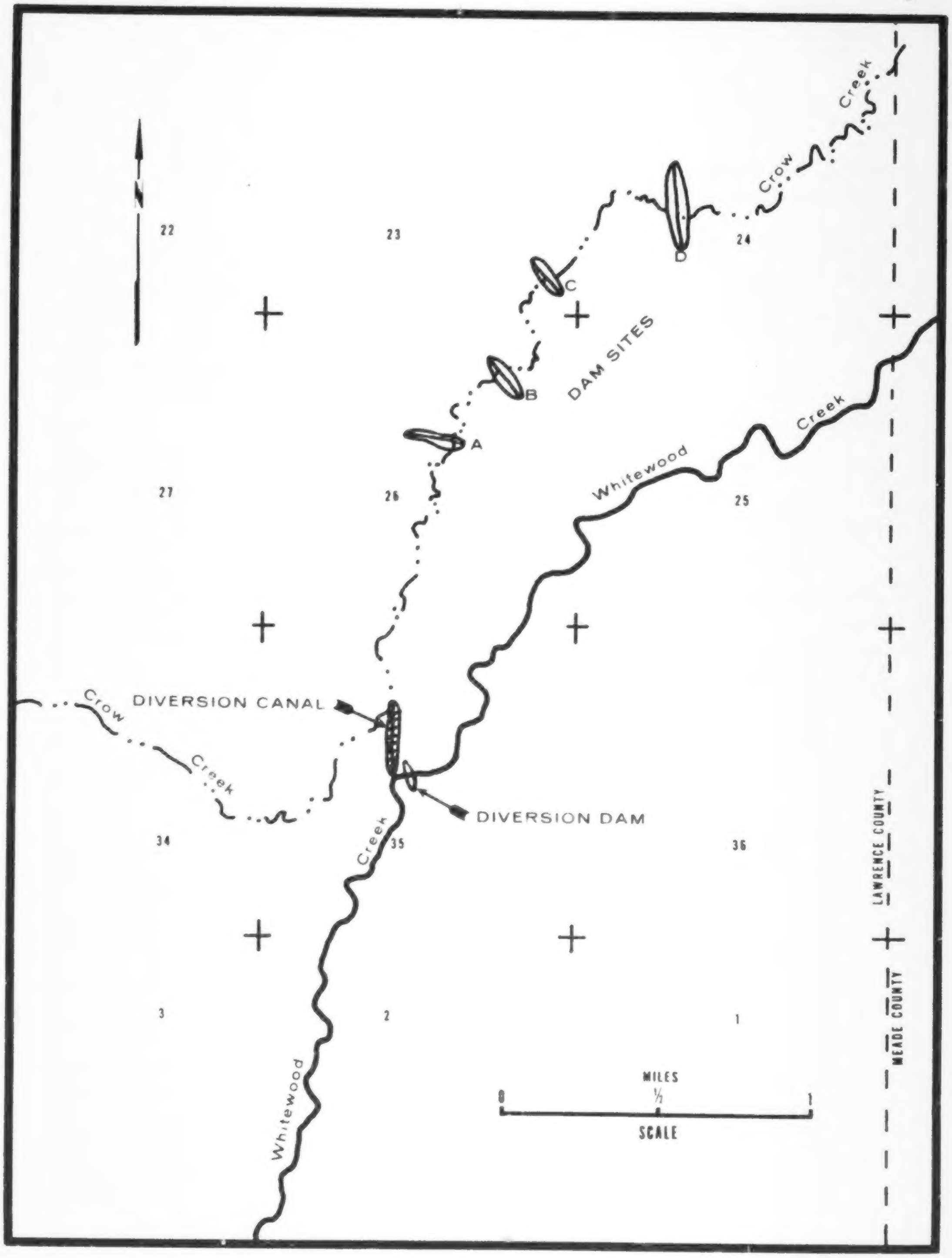

Figure 2. Crow Creek Diversion

REFERENCES

1. Reese, M. Lisle, 1952, "South Dakota, A Guide to the State", Hastings House, Inc., New York, p. 107.

2. South Dakota State Department of Health, Division of Sanitary Engineering, 1960, "Report on Water Pollution Studies, Gold Run Creek - Whitewood Creek - Belle Fourche River - Cheyenne River", Pierre, South Dakota.

3. South Dakota State Department of Health, Division of Sanitary Engineering, 1960, "Report on Gold Recovery Wastes, Homestake Mining Co.", Pierre, South Dakota.

4. McKee, J. E. and H. W. Wolf (eds), 1963, "Water Quality Criteria, 2nd Edition", the Resources Agency of California, State Water Quality Control Board, Sacramento, California, Pub. No. 3-A, 550 pp.

5. Study Group on Mercury Hazards, 1971, "Hazards of Mercury, Special Report to the Secretary's Pesticide Advisory Committee", Department of Health, Education, and Welfare, November, 1970; Environmental Research 4(1), 1-69.

APPENDIX A

April 23, 1971, Letter from Richard F. Kneip,
Governor of the State of South Dakota

to

William D. Ruckelshaus, Administrator,
Environmental Protection Agency

STATE OF SOUTH DAKOTA

RICHARD F. KNEIP
GOVERNOR

EXECUTIVE OFFICE

PIERRE
57501

April 23, 1971

William D. Ruckelshaus, Administrator
Environmental Protection Agency
Washington, D.C. 20460

Dear Mr. Ruckelshaus:

As you know, testing over the past year has revealed a potential mercury problem in western South Dakota. The problem stems from naturally-occurring mercury and from previous industrial discharges.

Industrial discharges of mercury began about 1876 when prospectors began using the metal for amalgamation of gold in placer mining operations on a number of Black Hills streams. How much mercury was discharged to the various streams by the early operators is not known; however, geologists of the South Dakota School of Mines and Technology report seeing free mercury in the sediments of several streams.

Though mercury is no longer being used in gold recovery operations, undetermined amounts of the metal remain in the sediments of Black Hills streams, particularly in the Whitewood Creek-Belle Fourche River-Cheyenne River system. Also, naturally-occurring mercury has been found in all of the other major streams of western South Dakota, seemingly associated with shale formations; no industrial discharges are known which could account for the mercury found in these streams. Further, the occurrence of mercury in fish from an impoundment of the Cheyenne River far upstream from the confluence of the Belle Fourche River indicates a natural source of mercury or perhaps mercury contamination from the uranium-processing operation at Edgemont.

As noted above, discharges of mercury from gold-recovery operations have been eliminated; and, to the best of our knowledge, there are no other significant discharges of mercury in the State. There remains, however, the mercury in Black Hills stream sediments as well as the naturally-occurring mercury elsewhere. Also, there is some question as to the significance of the cyanides that have been used for many years to supplement mercury amalgamation in gold recovery and are now used for all gold recovery.

Now, present evidence does not indicate that fish populations and other aquatic life are directly affected by the mercury nor is there any evidence that wildlife and domestic animals are suffering from mercury toxicity. More testing and study may be needed to substantiate these conclusions, however.

In our opinion, then, the crux of the problem in South Dakota, if there is a problem, is whether or not the levels of mercury thus far observed in fish flesh and in our waters have affected or may affect the health of South Dakotans and others who catch and eat the fish and use the water from the Cheyenne River system, including the Cheyenne Arm of Oahe reservoir, and the other streams and impoundments of western South Dakota. As you know, the interim guideline level of mercury in fish flesh established by the Food and Drug Administration has not been substantiated by clinical evidence and is subject to some controversy in the medical profession and other scientific circles.

Therefore, as provided in Section 10(d)(1) of the Federal Water Pollution Control Act, I am requesting that you call a conference of representatives of South Dakota State agencies having direct interest and responsibilities in the matter and representatives of such Federal agencies as have direct interest and responsibilities provided that at least one of the Federal conferees represents the Department of Health, Education and Welfare, and further provided that the conferees primarily address themselves to the problem of actual or potential mercury toxicity to humans, and to methods of control if such health hazards are demonstrated, and secondarily to the significance of the cyanide discharges. The occurrence, distribution, and significance of heavy metals other than mercury may concern the conferees as well.

In regard to State agency representatives, I am requesting that the following persons be appointed as conferees:

Dr. Robert H. Hayes, State Health Officer,
State Department of Health;

Robert A. Hodgins, Director
Department of Game, Fish & Parks; and

Joseph W. Grimes, Chief Engineer,
Water Resources Commission; and member,
South Dakota Committee on Water Pollution

I urge your favorable consideration of this request.

Sincerely,

Richard F. Kneip

RICHARD F. KNEIP
GOVERNOR

RFK/srd

cc: Dr. Robert H. Hayes
Robert A. Hodgins
Joseph W. Grimes

APPENDIX B

APPLICABLE WATER QUALITY STANDARDS

Excerpts from "Water Quality
Standards for the Surface Waters
of South Dakota, February 1967"

CHAPTER II - WATER QUALITY CRITERIA FOR SURFACE WATERS

Section II - Conditions Applying To All Surface Waters

1. Visible Pollutants. No raw or treated sewage, garbage, industrial wastes or agricultural wastes shall be discharged into any waters of the State which produce floating solids, scum, oil slicks, material discoloration, undesirable odors, visible gassing, sludge deposits, slimes, fungus growths or other offensive effects.

2. Toxic Materials. No materials shall be discharged to any surface water or watercourse in the State which produce concentrations of chemicals toxic to humans, animals or the most sensitive stage or form of aquatic life greater than 0.1 times the acute (96 hour) median lethal dose for short residual compounds or 0.01 times the acute median lethal dose for accumulative substances or substances exhibiting a residual life exceeding 30 days in the receiving waters.

   Acute median lethal concentrations shall be based on the results of the most recent research results for the material being studied or, in case of disagreement, by bioassay tests simulating actual stream conditions run in accordance with procedures outlined in "Standard Methods for the Examination of Water and Wastewater - 1965" published by the American Public Health Association and using test animals or organisms specified by the Committee.

   Concentrations specified for toxic materials shall be based on daily averages, but the concentrations shall not exceed 125% of the value specified at any time or in any section of the receiving water.

   These provisions shall not apply to those toxic materials for which specific limits are specified in the criteria for given beneficial uses.

3. Radioactive Materials. Radioactive materials shall not be permitted in the waters of the State unless these materials are readily soluble or dispersible in water and in quantities determined by the Committee to be in accord with criteria of the South Dakota State Department of Health or other appropriate State or Federal Agency.

4. Taste and Odor Producing Chemicals. No materials shall be discharged which will result in concentrations in the receiving water sufficient to impart objectionable tastes and odors to edible aquatic life.

5. Acids and Alkalis. With the exception of those watercourses in the Intermittent Stream category, no materials shall be discharged from any one source which shall affect the pH of the receiving waters by more than 1.0 unit within the limits specified herein.

CATEGORY NUMBER 2 - FISH LIFE PROPAGATION

Description: All waters in this category shall be such that they will provide a satisfactory environment for the class of fish described and for all other aquatic life essential to the maintenance and propagation of fish life. There shall be separate quality criteria for each of the following five sub-categories:

a.	Cold water permanent	All lakes, streams and reservoirs in this category shall be capable of supporting a good permanent trout fishery from natural reproductions or fingerling stockings.
b.	Cold water marginal	All lakes, streams and reservoirs in this category shall be suitable for supporting stockings of catchable size trout during portions of the year but due to low flows, siltation and warm temperatures will not support a permanent cold water fish population.
c.	Warm water permanent	Lakes, streams and reservoirs in this category shall be suitable for permanent maintenance of warm water fish including walleyes, black bass or blue gills.
d.	Warm water semi-permanent	Lakes, streams and reservoirs in this category shall be suitable for a quality warm water fishery but may suffer occasional fish kills because of critical natural conditions. Principal species managed in these waters will include walleyes, perch, northern pike or channel catfish.

e.	Warm water marginal	Lakes, streams and reservoirs in this category shall be suitable for supporting more tolerant species of fish with frequent stocking and intensive management. Principal species managed in these lakes include perch, northern pike or bullheads.

Criteria:

Criteria for each of the described sub-categories are presented in tabular form on the following page.

Criteria: (Fish Life Propagation-continued)

Parameter	Sub-Categories a	b	c	d	e	Frequency Code
Chlorides	100					c
Cyanides	0.02	0.03	0.02	0.02	0.05	a
Dissolved Oxygen (greater than)	6.0	5.0	4.0	4.0	2.0	a
Hydrogen Sulfide	0.3	0.5	0.5	1.0	1.0	a
Iron (total)	0.2	0.2	0.2	0.2		b
pH*	6.6-8.6	6.5-8.8	6.5-8.8	6.3-9.0	6.0-9.3	a
Suspended solids	30	90	90	90	150	c
Temperature (degrees F)	68	75	85	90	93	a
Turbidity**	25	50	50	100		c

Note: All values in mg/l unless indicated otherwise. The frequency code shown applies to all sub-categories.
* in pH units.
** Jackson Candle units.

Pesticides, herbicides and related compounds shall be treated as toxic materials and taste and odor producing chemicals and controlled under the provisions of Chapter II, Section II, subsection 2 and 4.

Temperatures shall not be affected by more than 4°F. in sub-categories a, b and c, and 8°F. in sub-categories d and e.

CATEGORY NUMBER 3 - RECREATION

Definitions: Water in this category shall be suitable for swimming, water skiing, skin diving, fishing, boating, sailing, picnicking and other water related types of recreation. There shall be separate quality criteria for each of the following two sub-categories:

a. Immersion Sports which would include swimming, water skiing, skin diving and other water sports.

b. Limited Contact Recreation which would include fishing, boating, sailing, picnicking and other water related recreation.

General: The criteria for recreation will normally apply only during the summer recreation season. However, if the receiving waters are used extensively for winter recreation, the criteria for limited contact recreation shall apply during the winter months.

Criteria:

Parameter	Limit	Frequency Code
a. Immersion Sports		
Coliform Organisms	Not to exceed a MPN or MF of 1000/100 ml as a monthly average; nor to exceed this value in more than 20% of the samples examined in any one month; nor to exceed 2,400/100 ml on any one day during the recreation season.	
Dissolved Oxygen	Greater than 2 mg/l	a
b. Limited Contact Recreation		
Coliform Organisms	Not to exceed a MPN or MF of 5000/100 ml as a monthly average; nor to exceed this value in more than 20% of the samples examined in any one month; nor to exceed 10,000/100 ml on any one day during the recreation season.	
Dissolved Oxygen	Greater than 2 mg/l	a

CATEGORY NUMBER 4 - WILDLIFE PROPAGATION AND STOCK WATERING

Definition: Waters in this category shall be satisfactory as habitat for aquatic and semi-aquatic wild animals and fowl and shall be suitable for watering domestic and wild animals and fowl.

General: No pollution shall be permitted to enter waters in this category which will produce inhibited growth, physical impairment or injurious effects on wild or domestic animals and fowl normally inhabiting or using the water.

Criteria:

Parameter	Limit	Frequency Code
Alkalinity (Total) (as $CaCO_3$)	750 mg/l	c
Total dissolved solids	2,500 mg/l	c
Electrical conductivity	4000 micromhos/cm @ 25° C.	c
Nitrates (as NO_3)	50 mg/l	b
pH	Greater than 6.0 and less than 9.5	a

APPENDIX C

WATER QUALITY DATA
WESTERN SOUTH DAKOTA
1959

Source: Report on
Water Pollution Studies
Gold Run Creek-Whitewood Creek
Belle Fourche River-Cheyenne River
1960

South Dakota State Department of Health
Division of Sanitary Engineering
Pierre, South Dakota

WATER POLLUTION ANALYSIS (1959) - GOLD RUN CREEK
STATION GR-0

Table C-1

Sampling Station	Collection Date	pH	Temp. °C.	D.O.		BOD	M.P.N.	CN	SO_3	SO_4	Solids	
				ppm	% Sat.						Suspended	Total
GR-0[1/]	6/23 *	8.6	17	6.4	66	80	11,000,000	0	0	379	112	1,000
GR-0	6/25 **	8.6	17	6.5	67	45	24,000,000		0	193	530	883
GR-0	7/6 ***							0.63				
GR-0	7/6 ***							2.53				
Average Values				6.5	66.5	63		1.05		286	321	942

Results in ppm for D.O., BOD, CN, SO_3, SO_4, Solids

* 3 hr. composite

** 4 hr. composite

*** grab samples (Homestake by-passing sand dams)

Samples for BOD, CN, SO_4, and solids composited, if not, otherwise indicated.

Note: Abbreviations for all Tables Nos. 1,2,3,4,5,6

D.O. = Dissolved Oxygen
ppm = parts per million
BOD = Biochemical Oxygen Demand (5 day)
MPN = Most Probable Number of coliform bacteria per 100 ml.
CN = Cyanide (all complex cyanides total reported as CN - by titration
SO_3 = Sulfides
SO_4 = Sulfate
% Sat. = Percent Saturation

1/ Gold Run @ Lead Sewage Outfall

Table reproduced from South Dakota report.

WATER POLLUTION ANALYSIS (1959) - GOLD RUN CREEK
STATION GR-1

TABLE C-2

Sampling Station	Collection Date	pH	Temp. °C.	D.O.		BOD	M.P.N.	CN	SO_3	SO_4	Solids	
				ppm	% Sat.						Suspended	Total
GR-1[1/]	6/23 **	8.8	17	6.6	68	70	4,600,000	0.95				1,482
GR-1	6/25 ***	8.7	17	6.1	63	25	46,000,000				804	
GR-1	7/7-8							2.8		384		1,429
GR-1	7/10-11	8.6						2.3	0			1,108
GR-1	7/11	8.4						2.1	0			1,382
GR-1	7/11-12	11.7						9.1	0			1,737
GR-1	7/12	8.7						3.6				1,564
GR-1	7/12-13	8.5						2.1				2,630
GR-1	7/13	8.5	17	6.6	68	55		0.86				2,614
GR-1	7/14-15	8.5	16*	4.7*	47*	35	2,400,000	2.9				1,755
GR-1	7/15-16	8.0	17*	5.1*	52*	40		1.23				2,324
GR-1	7/16	8.4	17*	4.9*	50*	45		0.60				1,452
Average Values				5.7	54	45		2.60				1,770

* Average of 3 tests
** 3 hr. composite
*** 4 hr. composite
All other samples 14 hr. composite (BOD, CN, SO_4, Solids)

[1/] Gold Run One Mile Below Sand Dam

Table reproduced from South Dakota report.

WATER POLLUTION ANALYSIS (1959) - WHITEWOOD CREEK
STATIONS WC-7, 9, & 10

TABLE C-3

Sampling Station	Collection Date	pH	Temp. °C	D.O.		BOD	M.P.N.	CN	SO_3	SO_4	Solids	
				ppm	% Sat.						Suspended	Total
WC-7[1/]	6/23 **	8.8	17					1.25				26,080
WC-7	6/25 ***	8.7	21									
WC-7	6/23 **	8.5	18	1.7	18	10		2.10		232	12,570	13,965
WC-7	6/25 **	8.6	22	3.1	35	100	430,000		0	209	15,466	15,750
WC-7	7/13	8.5	20*	1.5*	16.3*	45		1.03				24,175
WC-7	7/14-15	8.6	16*	3.6*	36.2*	65	11,000,000	1.10				26,916
WC-7	7/15-16	8.4	17*	3.2*	33*	60		0.69				18,205
WC-7	7/16	8.6	22*	3.7*	42*	75		0.78				22,056
Average Values				2.8	31	60		1.16		221	14,018	21,021
WC-9[2/]	6/23 ***	8.4	18					0.69				25,810
WC-9	6/25 ***	8.2	25									
WC-10[3/]	6/23 ***		25					0.69			23,350	
WC-10	6/25	8.0										
WC-10	7/14 ***	8.1	24*	5.4*	63*	40	1,500,000	0.62				35,497
WC-10	7/16 *** (1)	7.8	23*	6.2*	72*	8	93,000					1,898
Average Values				5.9	68	24		0.66				18,698

* Average 2 or 3 tests; ** 3 hr. composites; *** 4 hr. composites; others 12 hr. composites.
(1) Stream flow higher due to rain shower. Samples for BOD, CN, SO_4, and Solids composited.
1/ Whitewood Creek @ Deadwood
2/ Whitewood Creek @ Route 14 Bridge
3/ Whitewood Creek @ Bridge near Mouth

Table reproduced from South Dakota report.

WATER POLLUTION ANALYSIS (1959) - BELLE FOURCHE RIVER
STATIONS BF-1, 2, & 4

TABLE C-4

Sampling Station	Collection Date	pH	Temp. °C			BOD	M.P.N.	CN	SO_3	SO_4	Solids	
				ppm	% Sat.						Suspended	Total
BF-1[1/]	6/23		27	10.0	125	7	300				692	
BF-1	6/25	8.2	31	12.3	164	6	1,500				358	
BF-1	7/14	8.2	27*	6.7*	83*	5	93					2,425
BF-1	7/16	8.1	25*	7.9*	94*	5	93					2,063
Average Values				9.3	107	6.0					521	2,244
BF-2[2/]	6/23		27	1.3	16		460,000		0		10,650	
BF-2	6/25	7.9	29	2.0	26	17	1,500,000		0		8,980	
BF-2	7/14	8.0	25*	2.4*	28*	30	93,000					19,534
BF-2	7/16 **	7.8	24*	3.7*	43*	8	93,000					3,548
Average Values				2.3	31	18					9,815	11,541
BF-4[3/]	6/23		20	6.9	75	2	4,300		0		537	
BF-4	6/25	8.2	25	6.0	72	4	9,300				636	
BF-4	7/13	8.4	30	6.9	90	3	36	0.36				2,120
BF-4	7/15	7.9	29	6.8	88	4	2,400	0.5				2,179
Average Values				6.7	81	3.0		0.43			586	2,150

BF-1 and BF-2 (4 hr. composites) (BOD, CN, SO_4, and Solids)
BF-4 - grab samples

* Average of 2 tests
** Stream flow higher due to rain shower

[1/] Belle Fourche River South of Nisland
[2/] Belle Fourche River @ Route 79 Bridge
[3/] Belle Fourche River North of Elm Springs

Table reproduced from South Dakota report.

WATER POLLUTION ANALYSIS (1959) - CHEYENNE RIVER
STATION CR-1 & 2

TABLE C-5

Sampling Station	Collection Date*	pH	Temp °C	D.O.		BOD	M.P.N.	CN	SO_3	SO_4	Solids	
				ppm	% Sat.						Suspended	Total
CR-1[1/]	6/23		18	7.9	83	1.0	430		0		532	
CR-1	6/25	8.2	22	7.0	79	6.0	24,000				10,978	
CR-1	7/13	8.2	29	4.8	62	3.0	9,300					2,040
CR-1	7/15	8.2	26	7.2	88	2.0	2,300					1,825
Average Values				6.7	78	3.0					5,755	1,935
CR-2[2/]	6/23		21	7.5	84		4,300				1,370	
CR-2	6/25	8.4	17	7.0	72	3.0	9,300				352	
CR-2	7/13	8.2	30	7.3	96	5.0	3,900					7,246
CR-2	7/15	8.2	30	6.9	90	3.0	4,300	0.04				1,950
Average Values				7.2	86	4.0		0.04			861	4,600

* All grab samples

1/ Cheyenne River @ Wasta

2/ Cheyenne River @ Route 24 Bridge

Table reproduced from South Dakota report.

APPENDIX D

MERCURY CONCENTRATIONS IN FISH SAMPLES COLLECTED IN SOUTH DAKOTA IN 1970

Source:

South Dakota Department of Game, Fish, and Parks
South Dakota Department of Health

Table D-1

Mercury in South Dakota Fish Samples Collected During 1970 *
(in parts per million)

LAKES & RESERVOIRS:

Big Stone L., Roberts Co., 06-18-70 -

Carp	trace
White bass	0.12
Perch	0.06

Buffalo L., Marshall Co., 04-29-70 -

Northern pike	0.08
Sucker	0.03
Bullhead	0.06
Perch	0.02
Walleye	0.03

Clear L., Deuel Co., 04-29-70 -

Northern pike	0.07
Sucker	0.03
Bullhead	0.06
Perch	0.05

North Waybay L., Day Co., 04-29-70 -

Northern pike	0.11
Carp	0.03
Sucker	0.04
Walleye	0.11

Red Iron L., Marshall Co., 04-29-70 -

Northern pike	0.03
Sucker	0.02
Bullhead	0.06
Crappie	0.03
Perch	0.03

Shadehill Reservoir of Grand R., 10-14-70 (Analyses by Dow Chemical Co.) -

Catfish (2 fish)	0.26
Walleye (2 fish)	0.26

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* Food & Drug Adm. analyses except as noted. FDA rejection level for fish flesh is 0.5 parts per million.

Dow Chemical Co. analyses provided by Homestake Mining Co.

Table prepared by South Dakota Department of Game, Fish & Parks, and South Dakota Department of Health, reproduced as provided.

Table D-1 (cont'd)
Mercury in South Dakota Fish Samples Collected During 1970
(in parts per million)

LAKES & RESERVOIRS (cont'd):

L. Traverse, Roberts Co., 06-23-70 -

Bullhead	0.04
White bass	0.06
Crappie	0.07

MISSOURI IMPOUNDMENTS (other than Oahe):

Garrison Reservoir, 10-13-70 (Analyses by Dow Chemical Co.) -

Northern pike (one fish)	0.51 **
Carp	0.16
Walleye (2 fish)	0.38

L. Francis Case (Ft. Randall Res.), Gregory Co., 08-12-70 -

Carp	0.12
Walleye	0.08

Lewis & Clark L. (Gavin's Point Res.), Bon Homme Co., 08-12-70 -

Carp	0.05
Sauger	0.06
Walleye	0.05

OAHE RESERVOIR:

Just below Bismarck, N.D., 07-?-70 -

Northern pike	0.34
Buffalo	0.23
Walleye	0.30

At U.S. 212 bridge (Whitlock's Crossing), 5-21-70 -

Northern pike	0.12
White bass	0.08
White crappie	0.10
Black crappie	0.22
Perch	0.09
Sauger	0.13
Walleye	0.17

** Exceeds FDA Guideline

Table D-1 (cont'd)

Mercury in South Dakota Fish Samples Collected During 1970
(in parts per million)

OAHE RESERVOIR (cont'd):

At U.S. 212 bridge, 08-?-70 -

Northern pike	0.10
Goldeye	0.16
Channel catfish	0.11
White bass	0.37
Black crappie	0.40
Perch	0.14
Walleye	0.13

Cheyenne Arm, Foster Bay area, 05-21-70 -

Northern pike	0.27
Carp	0.16
Smallmouth buffalo	0.14
Bigmouth buffalo	0.33
Channel catfish	0.14
White bass	0.32
White crappie	0.32
Black crappie	0.35
Sauger	0.27
Walleye	0.20

Cheyenne Arm, Foster Bay area, 08-?-70 -

Northern pike (one fish)	1.12 **
Goldeye	0.19
Channel catfish	0.26
White bass	0.84
Walleye	0.68

Cheyenne Arm, Foster Bay area, 10-13-70 -

Northern pike (two 4-lb. fish)	1.16 **
Northern pike (two 1½-lb. fish)	0.23
Carp	0.32
Channel catfish	0.38
White bass	0.54 **
Walleye	0.65 **

** Exceeds FDA Guideline

Table D-1 (cont'd)

Mercury in South Dakota Fish Samples Collected During 1970
(in parts per million)

OAHE RESERVOIR (cont'd):

Cheyenne Arm, Minneconjou Bay area, 10-14-70 -

Northern pike (one 4-lb. fish)	0.32
Goldeye	0.24
Carp (one 3-lb. fish)	0.38
Channel catfish	0.18
White bass	0.38
Walleye	0.38

CHEYENNE RIVER SYSTEM:

Angostura Reservoir, Fall River Co., 07-29-70 -

Channel catfish	0.08
Black crappie	0.12
Largemouth bass	0.20
Perch	0.10
Walleye (one fish)	0.52 **

S. Fork, Rapid Creek, 10-4-70 (Analysis by Dow Chemical Co.) -

Trout	0.07

Keyhole Reservoir of Belle Fourche R., Wyoming 10-20-70 -
(Analyses by Dow Chemical Co.) -

Perch (two fish)	0.18
Walleye	0.18

Belle Fourche R., near Fruitdale, 07-29-70 -

Goldeye	0.38
Carp	0.24
Sucker	0.08
Carpsucker	trace
Channel catfish	0.12
Green sunfish	0.06
Largemouth bass	0.40

** Exceeds FDA Guideline

Table D-1 (cont'd)
Mercury in South Dakota Fish Samples Collected During 1970
(in parts per million)

CHEYENNE RIVER SYSTEM (cont'd):

Belle Fourche Reservoir, 10-21-70 (analyses by Dow Chemical Co.) -

Carp (one fish)	0.12
Carp (one fish)	0.30
Sucker (one fish)	0.14

Spearfish Creek, 10-24-70 (Analysis by Dow Chemical Co.) -

Trout	0.23

Belle Fourche R., at S.D. 34, 07-28-70 -

Goldeye	0.32
Sauger	0.76 **

** Exceeds FDA Guideline

APPENDIX E

Results of Recent EPA
Surveys in Western
South Dakota

TABLE E-1. Distribution of Benthic Animals - Cheyenne and Belle Fourche Rivers, and Tributaries - May, June, and July 1971

Station No.	4314.70	4329.50	4360.00	6-4361.10	6-4361.30	6-4361.40	6-4361.00	6-4361.25	6-4361.50	6-4361.70	4370.00	4025.50	4060.00	4130.00	4255.00	4235.00	4385.00
Date	5/30	6/9	7/20	5/29	5/29	5/29	5/29	5/29	5/29	5/29	7/20	6/10	6/10	6/7	7/22	7/21	7/21
Diptera					1		21										1
Chironomidae	2	22	6		9		263				1	Q	Q	Q	1	253	1
Diamesinae	2						35							Q			
Diamesa							35										
Pentaneurinae							Q										
Pentareura												3					
Orthocladiinae	5	Q*			10	Q	165				2	Q		87			
Cricotopus		Q															
Eukiefferiella					Q												
Psectrocladius	4				Q												
Chironominae						Q											
Pseudochironomus														Q			
Tanypodinae					2		5										
Coelotanypus		Q															
Tipulidae		Q					11										
Antocha	12																
Hexatoma	Q																
Simuliidae	64		Q								4						
Simulium		2				Q						270	210	44	1	464	137
Stratiomyiidae					1												
Tabanidae					26		4										
Muscidae													1				
Tricoptera		2	16														1
Hydropsychidae																	
Hydropsyche	6	21	41		48		120						8	9	Q	1	
Cheumatopsyche		16	160		5		10				1				3	23	8
Brachycentridae																	
Brachycentrus	2						1										
Leptoceridae																	
Leptocella																Q	

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* Q = Collected in qualitative sampling only. Arbitrarily assigned a value of one for counting.

TABLE E-1. Distribution of Benthic Animals - Cheyenne and Belle Fourche Rivers, and Tributaries - May, June, and July 1971

Station No.	4314.70	4329.50	4360.00	6-4361.10	6-4361.30	6-4361.40	6-4361.00	6-4361.25	6-4361.90	6-4361.70	4370.00	4025.90	4060.00	4130.00	4255.00	4235.00	4385.00
Date	5/30	6/9	7/20	5/29	5/29	5/29	5/29	5/29	5/29	5/29	7/20	6/10	6/10	6/7	7/22	7/21	7/21
Lepidostomatidae																	
Lepidostoma			Q		99		2										
Phryganeidae																	
Ptilostomis	2				Q												
Rhyacophilidae	Q				Q												
Hydroptilidae		Q															
Plecoptera																	
Perlodidae																	
Isoperla		5			35		3						5	2			
Isogenus					Q		1										
Chloroperlidae					Q	Q	Q										
Chloroperla	Q											1					
Perlidae																	
Acroneuria	1				Q		1										
Perlinella							8										
Ephemeroptera																	
Ephemeridae																	
Potamanthus			19												1		
Ephoron			Q														3
Heptageniidae													2				
Iron	89				76	Q	106					Q	Q	2		Q	
Stenonema			3													3	
Cinygmula															2		6
Heptagenia			Q								17				Q		Q
Baetidae		1			2										4		
Baetis	79	10			97	Q	20				Q	13	51	11	34	15	Q
Caenis																	19
Tricorythodes		2	3										Q		Q	2	7
Ephemerella		7			31		125						2	17			Q
Paraleptophlebia					8		Q							1			
Pseudocloeon		27															
Neocloeon			Q														
Isonychia			Q								4						4

TABLE E-1. Distribution of Benthic Animals - Cheyenne and Belle Fourche Rivers, and Tributaries - May, June, and July 1971

Station No.	4314.70	4329.50	4360.00	6-4361.10	6-4361.30	6-4361.40	6-4361.00	6-4361.25	6-4361.50	6-4361.70	4370.00	4025.50	4080.00	4130.00	4255.00	4235.00	4385.00
Date	5/30	6/9	7/20	5/29	5/29	5/29	5/29	5/29	5/29	5/29	7/20	6/10	6/10	6/7	7/22	7/21	7/21
Coleoptera		3	Q		1		14										
Dystiscidae													1			Q	Q
Hydaticus												Q					
Elmidae					1		5							6			
Stenelmis					2		1										
Dryopidae			2														
Gyrinidae																	
Gyrinus							1										
Odonata																	
Anisoptera																	
Erpetogomphus													Q				
Hemiptera			Q														
Lepidoptera																	
Paragyractis													1				
Oligochaeta		12	2		3		17					6	14				
Enchytraeidae														2			
Lumbricidae														1			
Gastropoda			1									2		Q	Q		
Physa					14		2										
Hirudinea													Q				
Hydracarina							1										
Amphipoda															Q		
Total Number of Organisms/sq. ft.	271	135	261	0	478	6	980	0	0	0	30	299	300	186	51	764	191
Total Number of Kinds	13	17	17	0	23	6	26	0	0	0	6	10	15	15	11	10	14

Table E-2. Arsenic and Mercury Concentrations in Stream Sediment Samples from Western South Dakota

Station Number	Station Location	Date Sampled	Arsenic mg/g	Mercury mg/kg (Dry weight)
4200.5	Boxelder Creek at Owanka, S.D.	6/10	0.0152-0.0211*	<0.02
4235	Cheyenne River at Wasta, S.D.	6/10	0.00823-0.0101	<0.04
4255	Elk Creek near Elm Springs	6/10	0.0202-0.0206	0.04
4361.0	Whitewood Creek at U.S. 85 Bridge	5/29	0.689-0.831	0.54
4361.3	Deadwood Creek above Deadwood, S.D.	5/29	0.618-0.789	0.12
4361.5	Whitewood Creek at Deadwood Rodeo Gr.	6/11	2.07-2.20	0.18
4361.6	Whitewood Creek below Whitewood, S.D.	6/11	2.93-4.26	0.23
4361.7	Whitewood Creek near Vale, S.D.	5/26	3.73-4.35	0.72
		6/11	1.19-1.29	0.10
4370	Belle Fourche River Sturgis, S.D.	6/10	3.60-3.99	0.75
		6/11	2.23-2.88	1.1
4375	Bear Butte near Sturgis, S.D.	6/10	0.0174-0.0201	0.06
4385	Cheyenne River near Plainview, S.D.	6/11	0.698-0.729	0.83
Homestake Mill Feed			3.32-4.01	0.57

* Numbers are range of results for triplicate analysis.

TABLE E-3

RESULTS OF LABORATORY ANALYSIS IN STREAMS SAMPLES COLLECTED IN WESTERN SOUTH DAKOTA DURING 1971

Sta. No.	Station Location	1971 Date	Time	Flow cfs	Mercury µg/l	Cyanide mg/l	Arsenic µg/l*	Antimony mg/l	Cadmium mg/l	Cobalt mg/l	Copper mg/l	Iron mg/l	Lead mg/l	Zinc mg/l
4020	Fall River at Hot Springs, S.D.	7/19	1530	18	< 0.3	-	-	-	-	-	-	-	-	-
4040	Battle Creek at Hayward, S.D.	6/12	1130	44	0.3	-	-	-	-	-	-	-	-	-
4115	Rapid Creek below Pactola Dam	6/12	1030	128	0.2	-	-	-	-	-	-	-	-	-
4200.5	Boxelder Creek at Owanka, S.D.	6/10	0930	15 Est.	0.6	-	N.D.	<1	0.05	0.0	0.00	2.1	<0.2	<0.02
4235	Cheyenne River at Wasta, S.D.	6/10	1045	1920	0.4	-	N.D.	<1	0.00	0.0	<0.05	5.9	<0.2	0.03
		7/21	1547	74	< 0.3	-	-	-	-	-	-	-	-	-
		7/22	1500	76	< 0.3	-	-	-	-	-	-	-	-	-
4255	Elk Creek near Elm Springs, S.D.	6/10	1200	114	2.0	-	N.D.	0.0	<0.05	0.0	<0.05	15.2	<0.2	0.08
		7/21	1620	6.3	< 0.3	-	-	-	-	-	-	-	-	-
		7/22	1430	6.3	< 0.3	-	-	-	-	-	-	-	-	-
4314.7	Spearfish Creek below Maurice, S.D.	5/30	0930		0.5-2.3	-	-	-	-	-	-	-	-	-
4360	Belle Fourche River near Fruitdale, S.D.	6/10	1545	511	0.4	<0.02	N.D.	<1	<0.05	0.0	0.00	3.2	<0.2	<0.02
		7/20	0830	5.5	< 0.3	-	-	-	-	-	-	-	-	-
		7/21	0810	4.7	< 0.3	-	-	-	-	-	-	-	-	-
		7/22	0735	5.7	< 0.3	-	-	-	-	-	-	-	-	-
4361.0	Whitewood Creek at U.S. 85 Bridge	3/31	-	5.8	< 0.2	-	<1000	1	0.002	0.007	0.03	5.3	0.56	0.08
		6/8	1115	35.0	< 0.2	<0.02	13-12	<1	0.05	0.0	0.00	0.9	<0.2	<0.02
		6/9	1010	35.0	1.7	<0.02	-	-	-	-	-	-	-	-
		6/10	1023	35.0	0.2	<0.02	-	0.0	0.05	0.0	0.00	1.0	0.0	0.02

TABLE E-3 (Continued)

RESULTS OF LABORATORY ANALYSIS OF STREAM SAMPLES
COLLECTED IN WESTERN SOUTH DAKOTA DURING 1971

Sta. No.	Station Location	1971 Date	Time	Flow cfs	Mercury µg/1	Cyanide mg/1	Arsenic µg/1*	Antimony mg/1	Cadmium mg/1	Cobalt mg/1	Copper mg/1	Iron mg/1	Lead mg/1	Zinc mg/1
4361.1	Gold Run below Homestake Sand Dam	3/30-31	Comp*	9.2	3.8	1.1	1000	2	0.001	0.006	0.41	50	0.21	0.57
		5/5-6	Comp	12.9	4.2	2.1	-	-	-	-	-	-	-	-
		6/8	Comp	9.0	5.6	1.8	138-143	<1	0.07	0.0	0.69	185	<0.2	0.49
		6/9	Comp	10.4	12.0	3.6	420-340	<1	0.05	0.1	0.89	542	0.3	1.15
		6/10	Comp	14.5	2.8	0.5	-	-	-	-	-	-	-	-
4361.2	Homestake Slime Plant Effluent	3/30-31	Comp	4.0	0.8	9.8	1000	2	0.001	0.006	0.41	50	0.21	0.57
		5/5-6	Comp	4.0	26.0	9.9	-	-	-	-	-	-	-	-
		6/8	Comp	4.0	22.0	7.1	27-ND-17	<1	0.07	<0.1	0.05	437	<0.2	0.94
		6/9	Comp	4.0	15.2	7.4	910-952	-	-	-	-	-	-	-
		6/10	Comp	4.0	57.0	3.8	-	-	-	-	-	-	-	-
4361.3	Deadwood Creek above Deadwood, S.D.	3/31	-	21.2	< 0.2	-	< 500	1	0.001	0.007	<0.01	0.31	0.65	<0.01
		6/8	0830	12.0	0.3	<0.02	8.4-12.0	<1	<0.05	0.0	0.00	0.5	<0.2	1.11
		6/9	1100	11.1	1.4	<0.02	-	-	-	-	-	-	-	-
		6/10	0900	10.1	0.2	<0.02	-	0.0	0.05	0.0	0.00	0.4	<0.2	<0.02
4361.4	City Creek at Deadwood, S.D.	3/31	-	1.5	< 0.2	-	< 500	<1	0.001	0.002	0.01	2.3	0.65	0.02
		6/8	1010	2.1	1.5	<0.02	N.D.	0.0	0.06	0.0	<0.05	1.7	0.0	<0.02
		6/9	1255	2.0	0.2	<0.02	-	0.0	0.00	0.0	<0.05	1.8	0.0	<0.02
		6/10	1045	2.1	0.8	<0.02	-	-	-	-	-	-	-	-
4361.5	Whitewood Creek at Deadwood Rodeo Grounds	3/30-31	Comp	31.9	8.0	1.1	1700	1	0.003	0.004	0.11	225	0.70	0.45
		5/5-6	Comp	145.4	2.1	0.50	-	-	-	-	-	-	-	-
		6/8	Comp	68.9	6.4	0.82	970-880	<1	<0.05	<0.1	0.18	428	<0.2	0.60
		6/9	Comp	66.3	5.2	0.88	300-230	-	-	-	-	-	-	-
		6/10	Comp	74.3	7.6	0.79	-	-	-	-	-	-	-	-
4361.6	Whitewood Creek below Whitewood, S.D.	6/10	1250	90.3	-	0.58	1510-1420	<1	<0.05	<0.1	0.15	438	<0.2	0.59
		6/11	-	73.5	4.0	-	-	-	-	-	-	-	-	-

*Comp = 24-hour composite

TABLE E-3 (Continued)

RESULTS OF LABORATORY ANALYSIS OF STREAM SAMPLES COLLECTED IN WESTERN SOUTH DAKOTA DURING 1971

Sta. No.	Station Location	1971 Date	Time	Flow cfs	Mercury ug/l	Cyanide mg/l	Arsenic ug/l*	Antimony mg/l	Cadmium mg/l	Cobalt mg/l	Copper mg/l	Iron mg/l	Lead mg/l	Zinc mg/l
4361.7	Whitewood Creek near Vale, S.D.	6/10	1330	128.5	5.6	0.16	1900-1270	<1	0.00	<0.1	0.11	268	<0.2	0.33
		6/11	1105	101.1	3.2	-	-	-	-	-	-	-	-	-
		7/20	0915	20.4	1.0	-	-	-	-	-	-	-	-	-
		7/21	0850	20.4	0.6	-	-	-	-	-	-	-	-	-
		7/22	0815	20.4	5.0	-	-	-	-	-	-	-	-	-
4368	Horse Creek near Vale, S.D.	6/10	1510	157	0.4	<0.02	N.D.	<1	0.00	0.0	<0.05	11.4	<0.2	0.05
		7/20	1510	136	<0.3	-	-	-	-	-	-	-	-	-
		7/21	0917	133	<0.3	-	-	-	-	-	-	-	-	-
		7/22	0845	138	<0.3	-	-	-	-	-	-	-	-	-
4370	Belle Fourche River near Sturgis, S.D.	6/10	1610	931	0.6	<0.02	500-425-450	<1	<0.05	<0.1	0.05	31.6	0.3	0.08
		7/20	1615	348	<0.3	-	-	-	-	-	-	-	-	-
		7/21	1020	307	<0.3	-	-	-	-	-	-	-	-	-
		7/22	0945	378	<0.3	-	-	-	-	-	-	-	-	-
4375	Bear Butte Creek near Sturgis, S.D.	6/10	1630	62	0.2	-	N.D.	<1	<0.05	0.0	0.00	1.1	<0.2	0.02
		7/20	1605	22	<0.3	-	-	-	-	-	-	-	-	-
		7/21	1008	23	<0.3	-	-	-	-	-	-	-	-	-
		7/22	0930	26	<0.3	-	-	-	-	-	-	-	-	-
4380	Belle Fourche River near Elm Spring, S.D.	6/10	1300	1300	2.8	-	-	<1	<0.05	<0.1	0.07	58.8	<0.2	0.16
		7/21	1650	307	<0.3	-	-	-	-	-	-	-	-	-
		7/22	1400	291	<0.3	-	-	-	-	-	-	-	-	-
4385	Cheyenne River near Plainview, S.D.	6/10	1440	3500	0.8	<0.02	210-190	0.0	<0.05	<0.1	<0.05	15.7	<0.2	0.08
		7/21	1357	409	<0.3	-	-	-	-	-	-	-	-	-
		7/22	1305	415	<0.3	-	-	-	-	-	-	-	-	-
4393	Cheyenne River at Cherry Creek, S.D.	7/21	1300	424	<0.3	-	-	-	-	-	-	-	-	-
		7/22	1230	424	<0.3	-	-	-	-	-	-	-	-	-

*N.D. = None detected. Multiple numbers are results of multiple assay.

TABLE E-4

Mercury Concentrations in Fish Flesh - Belle Fourche and Cheyenne River Systems - May, June, and July 1971

Station No.	Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
4314.70	Spearfish Creek	6/9/71	Brook Trout	5	<0.02
			Brown Trout (fingerling)	1	<0.03
4329.50	Redwater River	6/9/71	Brown Trout	1	<0.04
			White Sucker	3	0.17
			Northern Redhorse	3	0.29
			Carp	2	0.58
			Creek Chub	2	0.19
4350.00	Belle Fourche Reservoir	5/27/71	Carp	3	<0.04
			Carpsucker	1	<0.04
			Yellow Perch	3	<0.03
			Northern Redhorse	2	0.07
			White Sucker	2	0.13
			Walleye	2	0.22
			Channel Catfish	1	<0.03
			White Bass	6	0.18
4360.00	Belle Fourche River at Fruitdale	6/8/71	Goldeye	1	0.29
			Carp	3	0.04
			Smallmouth Bass	1	0.17
			White Sucker	2	<0.03
			Green Sunfish	1	0.06
			Northern Redhorse	1	0.13
			Black Bullhead	1	<0.04
6-4361.00	Whitewood Creek, 50-100 yards upstream from Gold Run	5/29/71	Brook Trout	3	<0.04
			White Sucker	1	<0.04
			Longnose Dace	2	<0.04

TABLE E-4 (Continued)

Mercury Concentrations in Fish Flesh - Belle Fourche and Cheyenne River Systems - May, June, and July 1971

Station No.	Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
6-4361.10	Gold Run	5/29/71	No Fish Present		
6-4361.25	Whitewood Creek, 400 yards downstream from Gold Run	5/29/71	No Fish Present		
6-4361.30	Deadwood Creek	5/29/71	Brook Trout	5	<0.04
6-4361.50	Whitewood Creek at Rodeo Campgrounds	5/29/71	No Fish Present		
6-4361.70	Whitewood Creek near Vale, South Dakota	5/29/71	No Fish Present		
4370.00	Belle Fourche River at Highway 34, 15 miles downstream from Whitewood Creek	7/20/71	Carp	1	0.18
			Channel Catfish	1	0.16
			Creek Chub	2	0.39
4370.00	Belle Fourche River at Bear Butte Creek confluence (NOTE: Although these fish were collected from the mouth of Bear Butte Creek, they are considered Belle Fourche River fish because the creek becomes dry during the summer and fall. However, the period of their residence in the creek mouth is not known.)	6/8/71	Carpsucker	3	0.22
			Yellow Perch	1	0.03
			Carp	1	0.42
			Goldeye	1	0.47
			Creek Chub	6	0.22
			Northern Redhorse	1	<0.04
4010.00	Angostura Reservoir	5/26/71	Walleye	4	0.16
			Yellow Perch	6	<0.03
			Carp	1	0.03
			Crappie	6	0.14
			Channel Catfish	4	0.03

TABLE E-4 (Continued)

Mercury Concentrations in Fish Flesh - Belle Fourche and Cheyenne River Systems - May, June, and July 1971

Station No.	Location	Date	Kind of Fish	No. of Fish Analyzed (Composite)	Hg (ppm)
4025.50	French Creek	6/10/71	Longnose Dace	2	<0.04
			Carp	1	0.20
			Northern Redhorse	3	<0.02
			White Sucker	3	0.06
4060.00	Battle Creek	6/10/71	White Sucker	6	0.16
			Creek Chub	3	<0.04
4130.00	Rapid Creek	6/7/71	Brown Trout	6	<0.02
--	Cleghorn Springs Fish Hatchery, Rapid City, South Dakota	6/8/71	Brown Trout	6	<0.04
4255.00	Elk Creek	7/22/71	Longnose Dace	6	0.05
4235.00	Cheyenne River at Wasta, South Dakota	7/21/71	Channel Catfish	6	0.22
			Northern Redhorse	5	0.06
			Sauger	4	0.20
4385.00	Cheyenne River at Highway 34, 20 miles downstream from Belle Fourche confluence	6/9/71	Black Bullhead	1	0.19
			Sauger	3	0.82
			Goldeye	1	0.17
		7/21/71	Channel Catfish	1	0.41
			Largemouth Bass	1	0.20
			Carp	1	0.41
			Northern Redhorse	1	0.35
			Sauger	2	0.34

TABLE E-5

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Upper Cheyenne	10/7/70	Northern Pike	5	0.38
		Walleye	6	0.54
		White Bass	6	0.39
		Black Crappie	3	0.24
		Goldeye	6	0.22
		Channel Catfish	2	0.73
		Freshwater Drum	2	0.60
		Carp Sucker	6	0.23
		Carp	6	0.35
	4/27/71	Northern Pike	6	0.81
		Walleye	6	0.42
		White Bass	6	0.43
		Goldeye	6	0.29
		Channel Catfish	6	0.29
		Freshwater Drum	6	0.47
		Northern Redhorse	1	0.20
		Carp Sucker	6	0.22
		Carp	6	0.35
		Bigmouth Buffalo	5	0.34
	5/11/71	Northern Pike	1	1.05
		Walleye	6	0.56
		Sauger	6	0.57
		White Bass	6	0.74
		Goldeye	6	0.31
		Channel Catfish	6	0.39
		Freshwater Drum	6	0.39
		Northern Redhorse	1	0.11
		Carp Sucker	6	0.21
		Smallmouth Buffalo	1	0.24
		Carp	6	0.43
		Bigmouth Buffalo	6	0.48

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Foster Bay	12/3/70	Walleye	2	0.69
		Sauger	1	0.32
	5/1/71	Northern Pike	4	0.56
		Walleye	4	0.88
		Channel Catfish	4	0.53
		Black Bullhead	5	0.14
	5/19/71	Northern Pike	2	0.61
		Walleye	6	0.12
		Sauger	1	0.32
		White Bass	5	0.40
		Yellow Perch	1	0.08
		Goldeye	6	0.18
		Channel Catfish	6	0.21
		Black Bullhead	3	0.08
		Freshwater Drum	3	0.35
		Northern Redhorse	2	0.06
		Carp Sucker	5	0.11
		Smallmouth Buffalo	6	0.10
		Carp	6	0.20
		Bigmouth Buffalo	2	0.34
	6/4/71	Northern Pike	1	0.23
		Walleye	6	0.18
		Sauger	1	0.32
		White Bass	1	0.04
		Yellow Perch	1	0.04
		Goldeye	6	0.43
		Channel Catfish	2	0.13
		Black Bullhead	1	0.36
		Northern Redhorse	6	0.23

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Foster Bay (Continued)	6/4/71	Carp Sucker	4	0.14
	(Continued)	Carp	1	0.21
Ruby Creek	11/24/70	Walleye	2	0.37
		Sauger	2	0.55
		Goldeye	4	0.23
Fish Gut Creek	4/23/71	Northern Pike	3	0.42
		Walleye	6	0.67
		White Bass	6	0.50
		Burbot	3	0.24
		Yellow Perch	6	0.24
		White Crappie	2	0.42
		Black Crappie	3	0.66
		Goldeye	2	0.20
		Channel Catfish	2	0.34
		Black Bullhead	5	0.23
		Freshwater Drum	1	0.51
		Northern Redhorse	1	0.09
		Carp Sucker	3	0.13
		Carp	6	0.27
	4/29/71	Northern Pike	6	0.24
		Walleye	6	0.16
		White Bass	2	0.27
		Yellow Perch	2	0.21
		Goldeye	2	0.18
		Channel Catfish	3	0.28
		Freshwater Drum	1	0.51
		Northern Redhorse	1	0.09
		Carp Sucker	3	0.13
		Carp	6	0.27

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Fish Gut Creek (Continued)	5/13/71	Northen Pike	6	0.51
		Walleye	6	0.12
		Sauger	2	0.15
		White Bass	4	0.23
		Burbot	1	0.16
		White Crappie	2	0.48
		Black Crappie	2	0.60
		Goldeye	1	0.02
		Channel Catfish	6	0.17
Oak Creek	4/30/71	Northern Pike	3	0.11
		Walleye	6	0.30
		Sauger	3	0.22
		Yellow Perch	1	0.15
		Goldeye	7	0.24
		Channel Catfish	5	0.30
		Northern Redhorse	2	0.07
		Carp Sucker	1	0.21
		Smallmouth Buffalo	1	0.14
		Carp	6	0.24
	5/14/71	Northern Pike	2	0.76
		Walleye	6	0.27
		Sauger	4	0.32
		Goldeye	1	0.19
		Channel Catfish	6	0.27
		Shovelnose Sturgeon	3	0.18
		Freshwater Drum	1	0.50
		Northern Redhorse	4	0.08
		Carp Sucker	4	0.16
		Smallmouth Buffalo	2	0.27
		Carp	3	0.16
		Bigmouth Buffalo	3	0.33

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Agency Creek	5/21/71	Northern Pike	1	0.13
		Walleye	6	0.21
		Sauger	3	0.47
		White Bass	1	0.43
		White Crappie	1	0.42
		Goldeye	6	0.27
		Channel Catfish	6	0.15
		Shovelnose Sturgeon	5	0.59
		Freshwater Drum	1	0.30
		Northern Redhorse	1	0.09
		Carp Sucker	2	0.58
		Carp	6	0.66
		Bigmouth Buffalo	2	0.40
	6/4/71	Northern Pike	1	0.30
		Walleye	6	0.10
		White Bass	1	0.12
		Shovelnose Gar	2	0.34
		Black Crappie	1	0.31
		Goldeye	6	0.09
		Channel Catfish	6	0.42
		Shovelnose Sturgeon	5	0.15
		Northern Redhose	1	0.09
		Carp Sucker	5	0.10
		Carp	6	0.23
		Bigmouth Buffalo	3	0.22
Whitlock Bay	4/22/71	Walleye	2	0.11
		Sauger	1	0.22
		White Bass	1	0.38
		Yellow Perch	1	0.67

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Whitlock Bay (Continued)	4/22/71 (Continued)	Goldeye	1	0.19
		Channel Catfish	2	0.48
		Shovelnose Sturgeon	4	0.18
		Northern Redhorse	1	0.11
		Carp Sucker	2	0.16
		Carp	3	0.19
		Bigmouth Buffalo	3	0.61
	5/18/71	Northern Pike	2	0.55
		Walleye	6	0.17
		Sauger	3	0.26
		Burbot	1	0.30
		Yellow Perch	2	0.15
		Goldeye	6	0.68
		Channel Catfish	5	0.19
		Shovelnose Sturgeon	1	0.30
		White Sucker	2	0.07
		Northern Redhorse	6	0.10
		Carp Sucker	2	0.24
		Carp	6	0.29
		Bigmouth Buffalo	1	0.45
	5/25/71	Northern Pike	2	0.20
		Walleye	1	0.13
		White Bass	1	0.28
		Channel Catfish	6	0.20
		Shovelnose Sturgeon	6	0.20
		Carp	1	0.20

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Whitlock Bay (Continued)	6/2/71	Northern Pike	1	0.52
		Walleye	6	0.16
		Sauger	3	0.13
		Shovelnose Gar	6	0.44
		Yellow Perch	2	0.14
		White Crappie	3	0.14
		Goldeye	6	0.17
		Channel Catfish	6	0.22
		Stone Catfish	1	0.15
		Freshwater Drum	1	0.40
		White Sucker	1	0.19
		Northern Redhorse	5	0.09
		Carp Sucker	2	0.14
		Carp	6	0.17
Oahe Tailwater	12/1/70	Northern Pike	2	0.20
		Walleye	6	0.10
		Sauger	6	0.17
		White Bass	1	0.02
		Burbot	3	0.24
		Yellow Perch	1	0.04
		Goldeye	5	0.13
		Carp Sucker	6	0.20
	4/23/71	Walleye	6	0.16
		Sauger	4	0.13
		Goldeye	6	0.18
		Channel Catfish	6	0.29
		White Sucker	1	0.08
		Northern Redhorse	3	0.19
		Carp Sucker	6	0.15
		Carp	6	0.16
		Bigmouth Buffalo	6	0.24

TABLE E-5 (Continued)

Mercury Concentrations in Fish Flesh
Oahe Reservoir, South Dakota - 1970-71

Location	Date	Kind of Fish	No. of Fish Analyzed (Composites)	Hg (ppm)
Oahe Tailwater (Continued)	5/19/71	Walleye	6	0.10
		Sauger	1	0.13
		Goldeye	1	0.13
		Channel Catfish	6	0.13
		Black Bullhead	6	0.17
		Blue Sucker	4	0.18
		Northern Redhorse	6	0.05
		Carp Sucker	6	0.14
		Smallmouth Buffalo	5	0.14
		Carp	1	0.11
		Bigmouth Buffalo	3	0.14
Blue Blanket	4/9/71	Northern Pike	6	0.27
Pollock, S. D.		Northern Pike	6	0.25
Grand River	4/7/71	Northern Pike	6	0.36

TABLE E-6

MERCURY CONCENTRATIONS IN BOTTOM MUDS.
OAHE RESERVOIR, SOUTH DAKOTA. APRIL - JUNE, 1971.

Location	Date	South Shore	200 yds of South Shore	400 yds of South Shore	300 yds of South Shore	Middle	400 yds of North Shore	200 yds of North Shore	North Shore
Upper Cheyenne	4/27/71	.068			.28	.30		.32	.056
		.094			.49	.48		.53	.076
	5/10/71	.055	.24			.24		.18	.038
		.075	.39			.39		.31	.057
Minniconju	4/29/71	.055		.24		.20	.33		.037
		.081		.41		.35	.62		.052
	5/12/71	.034		.066		.066	.070		.051
		.045		.11		.11	.12		.078
Oak Creek	5/14/71	<.03				.069	.26		.049
		<.04				.12	.50		.068
	5/13/71	.036		.078		.10			.12
		.046		.13		.17			.16
Agency Creek	5/20/71	.02		.02		.03	.16		.03
		.02		.04		.06	.30		.04
	6/4/71	.02		.02		.02	.02		.03
		.02		.03		.03	.03		.04
Whitlock Bay	6/7/71	.054		.026		<.03	<.02		<.02
		.089		.081		<.08	<.05		<.04

Upper Figure - ppm wet weight
Lower Figure - ppm dry weight
Table prepared by Region VII, E.P.A.

TABLE E-7

MERCURY CONCENTRATIONS IN WATER (µg/1)
OAHE RESERVOIR, SOUTH DAKOTA. JUNE, 1971

		Shallow Water			Deep Water		
Location	Date	1 meter of Surface	Mid-depth	1 meter of Bottom	1 meter of Surface	Mid-depth	1 meter of Bottom
Foster Bay	6/9/71	<.2	<.2	<.2	<.2	<.2	<.2
Fish Gut Creek	6/11/71	<.2	<.2	<.2	<.2	<.2	<.2
Oak Creek	6/11/71	<.2	<.2	<.2	<.2	<.2	<.2
Agency Creek	6/3/71	<.2	<.2	<.2	<.2	<.2	<.2
Whitlock Bay	6/7/71	<.2	<.2	<.2	<.2	<.2	<.2

Table prepared by Region VII, E.P.A.

Table E-8. Logs of Core Holes Along Belle Fourche River

Location	Depth	Description
Transect 1, Along Upstream Side of Road, 1 Mile East of Vale, S.D.		
Bank Material		Silt, clayey, sandy, blue-gray, very plastic (2.2 ppm Hg)
Hole 1, five feet north of north bank	0-2'	Sand, clayey, iron stained, mica, angular (0.82 ppm Hg)
	2'	Bottom of hole, alluvium, iron cemented
Hole 2, 35 feet north of north bank	0-1'	Sand, iron-stained, angular, medium
	1'-2.75'	Sand, medium to coarse, iron-stained, cemented, with stringers of gray clay resembling Homestake slime
	2.75'-3.75'	Sand, blue-gray, silty, resembles Homestake sands (1.9 ppm Hg)
	3.75'-5.0'	Sand, tan, fine, medium-rounded, filled with ground water (ground water contains 34 μg/l Hg)
Hole 3, 65 feet north of north bank	0-2.5'	Sand, iron-stained, angular, medium
	2.5'-4'	Sand, medium to coarse, iron-stained and cemented, angular, with 2" stringer of blue-gray plastic clay (3.6 ppm Hg)
	4'-5'	Sand, tan, medium-round, with shale fragments

Table E-8. Logs of Core Holes Along Belle Fourche River (cont'd)

Location	Depth	Description
Transect 2, County Road 7 Miles East of Vale, S.D.		
Bank Material		Silt, clayey, sandy, blue-gray, plastic (1.7 ppm Hg)
Hole 1, cut in north bank of river	0-1.2'	Sand, cross-bedded, brown, iron-stained
	1.2'-6.5'	Sand, very fine, silty, clayey, plastic, resembling Homestake tailings (3.5 ppm Hg at 3', 4.5 ppm Hg at 6')
	6.5'	Bottom of hole in clean stream alluvium
Hole 2, 30 feet north of north bank	0-1.75'	Topsoil, tan
	1.75'-2.0'	Sand, medium, angular, iron-stained
	2.0'-9.0'	Sand, clayey, silty, plastic, blue-gray, resembling Homestake tailings (2.6 ppm Hg at 2.2', 2.0 ppm Hg at 5', 1.6 ppm Hg at 7', and 0.18 ppm Hg at 9')
	9.0	Bottom of hole in clean, water-filled alluvium (ground water contains 1.8 µg/1 Hg
Hole 3, 60 feet north of north bank	0-2'	Sand, medium, angular, iron-stained
	2'-3'	Sand, tan, parent material of area

Table E-9

Mercury and Arsenic Concentration in Western South Dakota Ground-Water Samples Downstream from Homestake Effluents

Date	Sample Source	Mercury µg/l	Arsenic µg/l
6/11	Willard Gralapp Well	0.6	<1.0
6/11	Well east of Gralapp Well	0.3	<1.0
6/11	Richter Ranch Well	0.2	<1.0
6/11	Thompson Ranch Deep Well	0.2	<1.0
6/11	Anderson Well on Belle Fourche River	0.4	
6/11	Transect 2, Hole 2, Alluvium	1.8	
5/27	Transect 1, Hole 2, Tailings	34	

APPENDIX F

SURVEY METHODOLOGY

APPENDIX F

SURVEY METHODOLOGY

A. STREAM SAMPLING

A network of stream and biologic stations was designed to evaluate the pollution effects of natural and unknown sources, as well as the known pollution from Homestake Mining Company. The network of stations is shown in Figure 1 at the back of this report.

Where possible, stream sampling was done at existing U. S. Geological Survey gaging stations. At those locations a continuous record of stream flow was available. At some locations, especially on Whitewood Creek, no USGS station was available. In these cases a reference mark was established and stream stage determined at the time of sampling. Stream flow was gaged, utilizing established stream-flow measurement techniques. The flow at the time of sampling was determined by use of rating curves.

Water samples from most of the stream stations were grab samples. Aliquots were collected from effluent streams on an hourly basis and composited into a single sample representing the average quality of the discharges during the day. Samples were collected manually and by mechanical sample collectors. The samples were fixed with the proper preservative, and transported to the laboratory for analyses. Cyanide samples were iced and shipped by air express.

Samples of stream sediment were collected at each of the sampling stations. Where possible, an effort was made to collect samples of similar grain size from similar hydraulic zones. Samples were collected by hand or by dredge and sealed in a clean, sterile bag. They were examined at the time of colllection by a geological engineer, and were also examined microscopically at the DFI-DC laboratory.

B. BURIED TAILINGS SAMPLING

Holes were drilled through the various deposits of buried tailings material, utilizing a six-inch diameter hand auger. Logs of the holes were prepared at the time of the drilling. As in the case of the stream sediment samples, samples of the cuttings were sealed in clean bags. The samples were visually examined at the time of collection, and microscopically examined at the DFI-DC laboratory. Ground-water samples were collected from the holes by the use of a Kemmerer sampler.

C. BIOLOGICAL SAMPLING

Bottom dwelling invertebrate animals (benthos) were collected at each sampling station by means of a Surber sampler. These organisms, plus qualitative samples collected by use of a No. 30 U.S. Standard Series sieve, were preserved in 10 percent formalin solution. Benthos were separated from debris, sorted and identified using standard taxonomic references, and counted. Results of analyses were expressed as numbers of organisms per square foot of stream bottom. Qualitative samples were sorted and identified, but not counted; these were arbitrarily assigned a value of one per square foot.

Fish were collected from Angostura and Belle Fourche Reservoirs by means of 200-feet long floating gill nets, and by use of fyke nets. Fish were collected from river and stream stations by use of an electric shocker. Representative specimens were collected at each station for mercury analyses.

D. ANALYTICAL PROCEDURES

The water samples for metals analysis were preserved in the field with 5 ml concentrated HNO_3/1. Samples for cyanide analysis were field preserved with NaOH to pH 11, iced, and shipped air express to Denver; these samples were analyzed within 24 hours. Samples of stream sediment were sealed in clean, sterile bags at each of the stream sampling stations.

Samples sent to the DFI-DC Laboratory in Denver were analyzed by the procedures recommended in the EPA Manual, Methods for Chemical Analysis of Water and Wastes, 1971. Briefly, these were as follows:

Cyanide analysis - Samples were digested with acid and a catalyst to convert all cyanides to hydrogen cyanide. The hydrogen cyanide was distilled and trapped in sodium hydroxide solution. The resulting sodium cyanide concentrations were determined colorimetrically by the pyridine - pyrazalone reaction.

Mercury - Water samples were digested with acid permanganate to convert any mercury to the mercuric form. Excess permanganate was removed with hydroxylamine and stannous sulfate was added to reduce the mercuric ions to elemental mercury. Elemental mercury concentrations were determined in a closed system by atomic absorption (Flameless AA procedure).

Fish and stream sediment samples were also analyzed for mercury by this procedure after initial digestion with concentrated H_2SO_4 according to the method of Uthe, et al[1/].

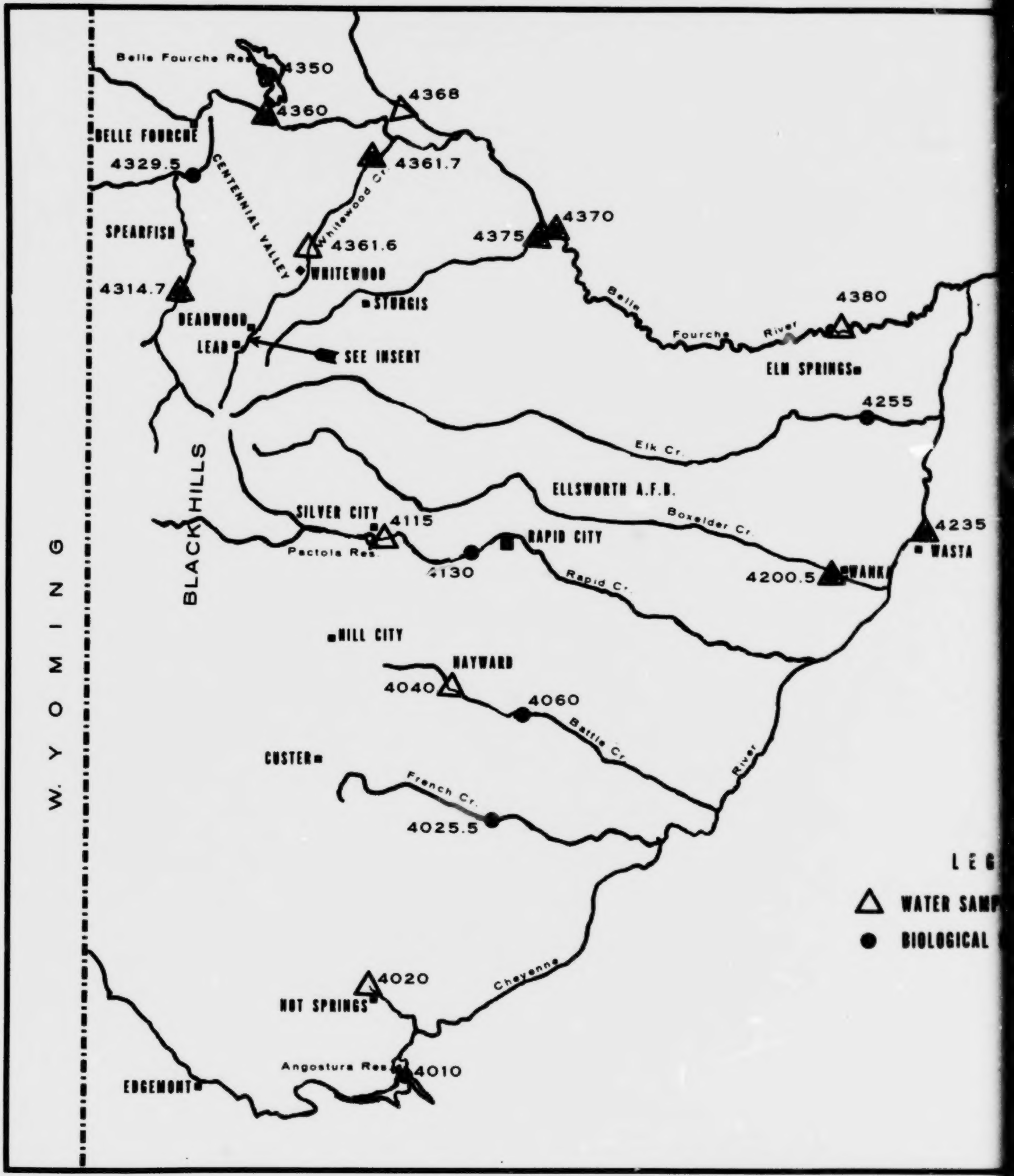
[1/] J. F. Uthe, F. A. J. Armstrong, and M. P. Stainton, J. Fisheries Research Board of Canada, 27, 805 (1970).

Total Solids - A known volume of well mixed sample was evaporated to dryness at 105°C. Total Solids were calculated on the basis of residue weight.

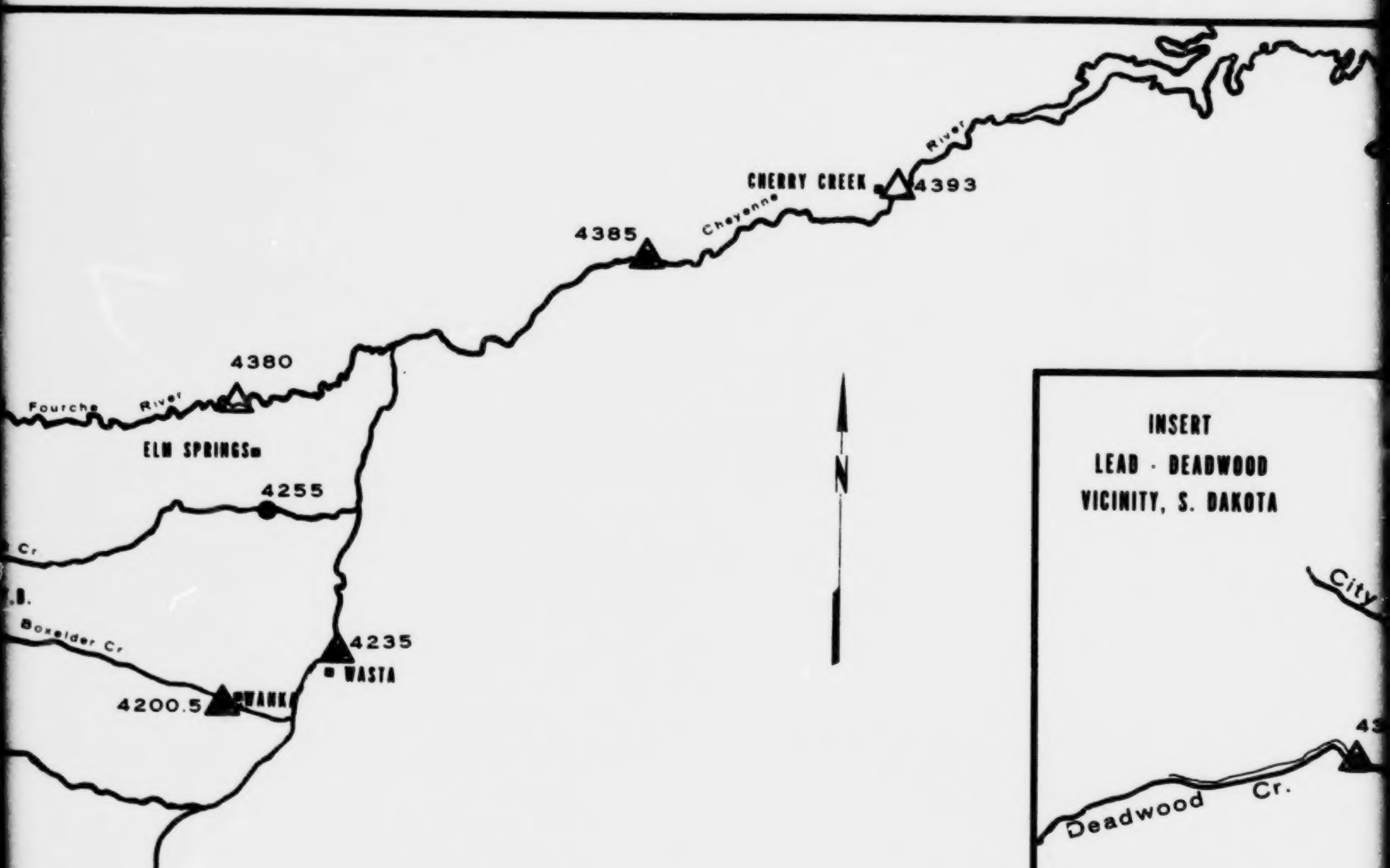
Suspended Solids - A known volume of well mixed sample was filtered through a tared gooch crucible. The crucible was dried at 105°C, cooled, and reweighed. Suspended solids were calculated from the weight gain.

Samples of water and stream sediment were shipped to the Southeast Water Laboratory in Athens, Georgia for arsenic analysis. Since sulfides in the samples interfered with the normal colormetric procedures, arsenic was determined by neutron activation.

Additional metals analyses were performed by the Midwest Research Institute, Kansas City, Missouri. Here, nitric acid preserved samples were tested directly by atomic absorption spectrophotometry.


Belle Fourche Res.
4350
4368
4360
BELLE FOURCHE
4329.5
CENTENNIAL VALLEY
4361.7
Whitewood Cr.
4370
4375
SPEARFISH
4361.6
WHITEWOOD
4314.7
STURGIS
DEADWOOD
LEAD
SEE INSERT
Belle Fourche River
4380
ELM SPRINGS
4255
Elk Cr.
BLACK HILLS
ELLSWORTH A.F.B.
Boxelder Cr.
SILVER CITY
4115
4235
Pactola Res.
RAPID CITY
WASTA
4130
Rapid Cr.
4200.5
WANKA
W. Y O M I N G
HILL CITY
HAYWARD
4040
4060
Battle Cr.
CUSTER
River
French Cr.
4025.5
LEG
WATER SAMP
BIOLOGICAL
4020
Cheyenne
HOT SPRINGS
Angostura Res.
4010
EDGEMONT

A



B

Figure 1. Location Map Showing Sampl

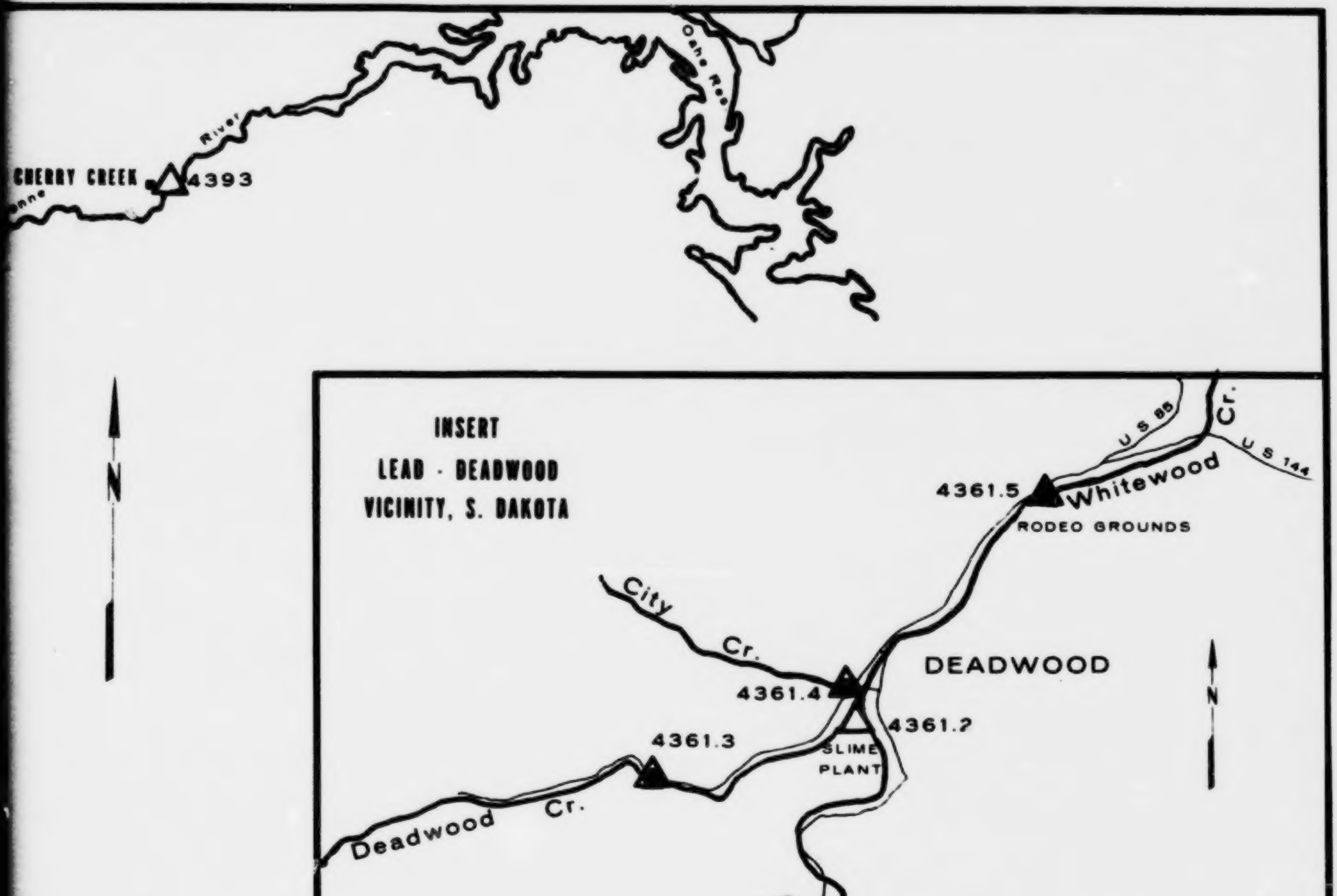


Figure 1. Location Map Showing Sampling Stations, Western South Dakota

C

MR. WARNER: During the summer of 1970 the U. S. Food and Drug Administration analyzed fish from the Cheyenne River Arm of Oahe Reservoir and other areas throughout western South Dakota. They found that mercury in the flesh of many fish in the Cheyenne Arm exceeded the FDA guideline of 0.5 ppm. Fish from other areas, notably Angostura and Belle Fourche Reservoirs, contained some mercury, but generally at levels less than the FDA guideline.

Since the latter part of the nineteenth century, mercury had been used for gold recovery at the Homestake Mining Company Lead-Deadwood mill. It has been reasonably well established that other mining activities in the Black Hills previously discharged mercury. Various State and Federal authorities have speculated that natural deposits of mercury minerals in the Black Hills and in marine shales throughout western South Dakota may cause mercury pollution.

Sampling in 1970 by the Environmental Protection Agency revealed that Homestake Mining Company was discharging from 12 to 40 pounds per day of mercury in their tailings slurry releases to Whitewood Creek, a tributary of the Cheyenne River system. The company discontinued the use of mercury in December 1970. Subsequent sampling revealed that the company was discharging cyanide, arsenic, and other toxic materials, together with vast quantities of suspended solids.

The Governor of South Dakota, by letter of April 23, 1971, under Section 10(d)(1) of the Federal Water Pollution Control Act, requested that the Administrator of the U. S. Environmental Protection Agency call a conference of State and Federal Agencies to consider the occurrence, distribution and significance of cyanide, mercury, and other metals pollution in western South Dakota.

This report presents the results of technical studies conducted in the Cheyenne River system by the National Field Investigation Center, Denver, Office of Enforcement, EPA.

Objectives of these studies were:

1. To investigate the effects of natural mercury deposits throughout the Cheyenne River system in western South Dakota.

2. To determine the location and extent of reservoirs of mercury and other toxic materials due to previous mining activity, and to measure the effect of the toxic substances on surface water, groundwater, and biota.

3. To document and characterize the discharge of tailings solids and various dissolved toxic pollutants from the Homestake Mining Company Deadwood-Lead mill.

4. To ascertain the movement and fate of these

pollutants in the hydrologic environment and the effect of these pollutants on the biota.

To meet these objectives, data gathered by State and Federal Agencies, universities, and companies were utilized. Special studies of biota, surface streams, groundwater and sediment were also conducted.

The cooperation and support of various Federal, State, and private agencies is gratefully acknowledged, and we didn't acknowledge the support of the State Game, Fish & Parks Department, which to me was considerable.

The Black Hills are the dominant physical feature of western South Dakota, extending for approximately 50 miles in the north-south direction and approximately 30 miles in the east-west direction. The mountain crests have an average elevation of approximately 6,000 feet, with isolated peaks exceeding 7,000 feet. Headwaters of most major western South Dakota streams rise in the Black Hills.

Precipitation throughout western South Dakota is closely related to elevation. The high areas of the Black Hills receive an annual precipitation of more than 20 inches per year while the plains areas receive less than 15 inches per year. Precipitation occurs both in the form of winter snows and early summer thunderstorms. Lake evaporation is approximately 40 inches per year.

The Black Hills uplift is the dominant geologic feature of western South Dakota. The elliptical dome has influenced the outcrop and dip of strata in an area approximately 125 by 60 miles. Crystalline rocks of pre-Cambrian age are exposed in the central portion of the Black Hills. These rocks are more resistant to erosion than surrounding rocks. This results in higher elevations and, hence, greater rainfall and runoff than from surrounding plains areas. The pre-Cambrian rocks have been extensively fractured and mineralized by subsequent intrusions. The mineralization includes arsenopyrite, an iron-arsenic sulfide, and cinnabar, mercuric sulfide.

Younger sedimentary strata dip radially away from the uplift, with formation outcrops in the form of concentric bands around the Black Hills, and are progressively younger with increasing distance from the dome. The sediments consist of limestones, sandstones, and shales. Some of the limestones and sandstones are regionally important aquifers. Several of the limestones contain solution cavities, which permit uninhibited movement of water.

Outside the Black Hills region, western South Dakota is underlain by Cretaceous and Tertiary shales, largely flatlying. These were deposited under marine and lacustrine conditions and contain numerous soluble salts. Such shales were suspected by South Dakota officials as sources of natural mercury pollution.

Most of western South Dakota is drained by the Cheyenne River and its tributaries, the chief of which is the Belle Fourche River. Both of these streams head in northeastern Wyoming, in an area of Tertiary shales and sandstones. They then flow around the Black Hills uplift, with the Cheyenne River passing to the south and the Belle Fourche River skirting the north end. Several streams drain from the Black Hills to join the rivers on the uplift margin. The drainage pattern of western South Dakota is thus greatly modified by the more resistant rocks exposed in the Black Hills.

Spring, French, Rapid, and Battle Creeks drain the southern Black Hills in the vicinity of Custer, Hill City, and Silver City. Much of the early mining took place in this region, with resultant disruption of the stream beds. Available information indicates that mercury was not widely used in this early mining.

Whitewood and Deadwood Creeks join in Deadwood at a point approximately 30 miles upstream of the confluence with the Belle Fourche River. The natural flow in both streams is minor except during runoff periods. The flow is augmented by the waste discharge from the Homestake sand dams and slime plant, and by the discharge of raw sewage from Lead and Deadwood.

Groundwater is available in western South Dakota from two sources: alluvium in bedrock valleys cut by surface streams, and consolidated aquifers which dip radially away from the Black Hills. The alluvial valleys are locally important as a source of water supply for ranches along the streams and are recharged by surface stream flow. The consolidated aquifers, sandstones and limestones, are regionally important as sources of supply, although the water is highly mineralized at points remote from outcrops of the various aquifers.

Mining of placer and lode gold deposits has occurred over much of the Black Hills region. In his letter requesting the western South Dakota pollution conference, Governor Kneip voiced concern over pollution resulting from past mining activities. Such pollution could include particulates eroded from old tailings piles, acids and metals from sulfide oxidation, and mercury from placer dredging and hard-rock milling.

Several inactive mill tailings piles, located west of Lead, were observed to be eroding during surface runoff events. Such runoff carries mineral-laden sediment into the watercourses, for subsequent leaching, and could be a source of water-quality degradation.

R. W. Warner

Prior to the end of 1970, all gold recovery from lode mines in the Lead-Deadwood area involved use of mercury for gold amalgamation. First milling was by use of an arrastra, followed by the advent of stamp mills. The Homestake Mining Company batch process was developed around the turn of the century. In it, amalgamation plates were used to recover large gold particles. The ground rock was then separated into sand and slime fractions, for subsequent cyanide leaching to recover fine gold particles. After the gold was leached from the ore, the spent rock was sluiced from the plant. Formerly, all the solids were discharged into Whitewood Creek. In recent years, Homestake Mining Company has returned approximately 80 percent of the sand fraction to the mine, to prevent subsidence. Due to the bulking effect which results during grinding of the ore, all the ground rock cannot be replaced in the mined spaces. Therefore, the remaining 20 percent of the sand fraction, and all the slime fraction, is sluiced directly into Whitewood Creek. Under present production levels, this results in a 2,735 ton per day discharge of suspended solids to Whitewood Creek. This material consists of finely-ground particles containing arsenopyrite, an arsenic-iron sulfide, and other sulfide minerals. The water solution used in sluicing the solids from the plant contains residual cyanide used in ore leaching.

The liquid and solid material contained mercury lost from the amalgamation plates.

After mercury was recognized as a serious pollutant, officials of Homestake Mining Company agreed to discontinue use of amalgamation as a gold-recovery method and to rely on the use of cyanide leaching for all gold recovery. This change was achieved early in 1971. Currently, the sand and slime fractions are treated in a series of cyanide washes and rinses, with gold recovery achieved by zinc-dust precipitation. Barren rock and cyanide are still sluiced directly into Whitewood Creek and affect water quality in the Belle Fourche and Cheyenne Rivers.

Deposits of previously-discharged tailings solids buried in active streams and abandoned meanders constitute a continuing source of toxic materials to surface streams of western South Dakota and may pollute nearby groundwater.

The towns of Lead and Deadwood have only rudimentary sewage-treatment facilities. Collection systems are old and carry storm runoff, infiltration, and sanitary sewage. Most of the sewage from Lead and Deadwood is discharged directly to Whitewood Creek, with no treatment.

Water quality standards for surface waters of South Dakota were adopted by the South Dakota Committee on Water

Pollution February 16, 1971, and were subsequently approved by the Secretary of the Interior.

The standards, under general requirements, specify that no sewage or industrial waste shall be discharged which produces, among other effects, material discoloration, sludge deposits, or other offensive effects. The general provisions also prohibit the discharge of toxic materials which may harm aquatic life.

The standards specify that the Belle Fourche and Cheyenne Rivers are for warm water semi-permanent fishery, limited contact recreation, wildlife propagation and stock watering, and irrigation. Numerical limits for several important constituents which apply for such uses are:

Cyanide, less than 0.2 mg/l
Iron, less than 0.2 mg/l
pH, 6.3 to 9.0
Suspended solids, less than 90 mg/l
Turbidity, less than 100 Jackson Turbidity Units

Correction on the cyanide. That should have been 0.02 mg/l.

No numerical standards have been established for Whitewood Creek.

The first known cognizance of pollution from the

Homestake operation is contained in "South Dakota, A Guide to the State," a WPA author's project book. In this publication, it is stated that "Whitewood Creek, once a crystal-clear tumbling mountain stream, now a dirty leaden color, literally a flow of liquid mud, caused by the tailings from the Homestake Mine at Lead, flows through the center of Deadwood. Livestock will drink the water along the lower reaches; but no animal life is possible in it."

An early study of the waste loads discharged by Homestake, and their effects on receiving streams, was carried out in June and July 1959, by the South Dakota Department of Health, with assistance from the U.S. Public Health Service. In two reports, published in 1960, the State Department of Health reported a discharge of 2,400 tons per day of tailings solids and 133 pounds per day of cyanide to Whitewood Creek. One of these disclosed that the waste destroyed all life in Whitewood Creek and the first several miles of the Belle Fourche River downstream from the mouth of Whitewood Creek. Concentrations of cyanide in Whitewood Creek below the Homestake discharges ranged to over 2.10 mg/l. Cyanide was detectable in the Belle Fourche and Cheyenne Rivers, below the Whitewood Creek inflow.

A settling-tank study conducted in conjunction with the 1959 survey indicated that significant water quality improvement could be achieved by installation of a tailings pond. Accordingly, in the "Report on Gold Recovery Wastes," the State recommended that "Programming be initiated to exclude solids from the receiving stream."

By August 1970, no progress had been made in the Homestake waste treatment practices and the tailings solids were still being discharged to Whitewood Creek. The discharges were found to contain significant quantities of mercury, with concentrations as high as 124 µg/l.

Following the discovery of high mercury levels in the streams, Homestake Mining Company was requested to discontinue use of mercury in its amalgamators and discontinued use of mercury amalgamation in December 1970. Homestake officials agreed, and removed all mercury from the milling cycle by January 1971. Samples were collected downstream of the Homestake Mill shortly after amalgamation was discontinued. High levels of mercury in the effluent indicated the presence of residual mercury in the milling equipment. There is continued presence of mercury in Whitewood Creek downstream of the Homestake discharges. Cyanide concentrations in Whitewood Creek were at levels considered harmful to fish.

The flesh of fish from the Cheyenne River Arm of

Oahe Reservoir was found to contain mercury at levels greater than the FDA guideline of 0.5 ppm. Results of fish sampling throughout western South Dakota during 1970 show that two fish samples, or 3.8 percent of the analyses, from the areas not influenced by Homestake discharges exceeded the FDA guideline of 0.5 ppm. Seven fish samples, or 15.2 percent of the analyses,from the area influenced by Homestake discharges exceeded the FDA guideline.

Water samples were collected by EPA from streams in the Lead-Deadwood area during March and May 1971 for mercury and cyanide analysis. Sampling of bottom sediments and core drilling of buried tailings deposits was accomplished during May. A major water quality and biological survey of western South Dakota streams was conducted during May, June, and July 1971. The May and June sampling was done during abnormally high stream flows and frequent rains, while the July sampling period was during a period of more normal climatic conditions.

The pollutants discharged to the streams investigated during this survey may be separated into three categories: toxic material, inorganic sediment, and organic wastes. The following discussion of toxicity is taken from McKee and Wolfe, and from "The Study Group on Mercury Hazards." Toxic materials include such pollutants as cyanide, arsenic, and mercury.

Cyanide toxicity is affected by pH, dissolved oxygen, temperature, and minerals in solution. Game fish cannot tolerate 0.2 mg/l of cyanide for 96 hours and 1.0 mg/l will inhibit organisms that exert biochemical oxygen demand. Invertebrate organisms can tolerate no more than 4.0 mg/l of cyanide in water. In the next sentence there is an error in printing and it should read: Arsenic in water is toxic in the range of 2 to 3 mg/l in some of the fish known to inhabit the study area and may not be harmful to insect larvae at 20 mg/l. The toxicity of mercury to aquatic biota depends upon its chemical state. Elemental mercury is relatively insoluble in water; therefore, aquatic organisms usually are not exposed to it in high concentrations. However, elemental mercury is readily methylated by microorganisms and becomes quite soluble. Methylated mercury compounds are readily taken up by aquatic organisms and may be toxic or accumulative in the organisms. Thus, fish exposed to minute mercury concentrations may accumulate it in their tissues to levels hazardous for human consumption. Mercury concentrations from 4 to 20 μg/l may be harmful to fish, while approximately 40 μg/l is harmful to invertebrates. The U. S. Food and Drug Administration recommends that fish containing 0.5 ppm mercury not be eaten.

The second category of pollutants is solid matter suspended in the water, primarily finely-ground and extremely dense mill tailings. These solids settle on stream bottoms, destroy habitats and smother aquatic organisms. The pollutional effect is deletion of organisms and the result is difficult to distinguish from toxic effects.

The third category of pollutants, domestic and agricultural wastes, produce water quality conditions which tend to favor the growth of pollution tolerant organisms, to the exclusion of sensitive forms. The benthos often consist of sludgeworms, midge larvae, leeches, and snails rather than stonefly and mayfly nymphs. Fish populations are often represented by carp and suckers rather than game fish.

May we have the slides?

I know it is difficult to read, but the Lead-Deadwood area would be on the top of that slide in the corner and Edgemont is blown up in the bottom right corner. The Cheyenne River system comes in from the lower left and flows up toward the upper right. The Oahe Reservoir is at the top.

A water sample collected from the Cheyenne River at Wasta, South Dakota, during high runoff in June of 1971 contained 0.4 μg/l of mercury, or 4.5 pounds of mercury per day. The sample did not contain detectable arsenic or significant quantities of other toxic metals. Mercury was not detected in samples collected in July, during normal streamflow. The mercury load in the June sampling resulted from the leaching of mercury-bearing suspended sediment. A bottom sediment sample from the site contained only 0.04 ppm of mercury. This indicates that high mercury concentrations in the stream are not concommitant with normal stream flow.

Battle Creek drains an area of previous mining activity, upstream of Hayward. A water sample collected from the creek contained 0.3 μg/l of mercury, or 0.07 pounds per day. Rapid Creek also drains an area of previous mining activity. A water sample collected from Rapid Creek below Pactola Dam contained 0.2 μg/l of mercury, or 0.14 pounds per day. These findings indicate that previous mining sites are not significant mercury pollution sources.

Boxelder Creek heads in the Black Hills, flows by Ellsworth Air Force Base, and drains a large Cretaceous shale area. A water sample collected at Owanka contained 0.6 μg/l of mercury or 0.05 pounds per day. This concentration apparently resulted from leaching of shale washed into the stream during previous rainfalls. No detectable arsenic was found in the sample. Sediment from this station contained only 0.02 ppm of mercury, which indicates that mercury is not normally present in significant quantities in the stream.

Elk Creek heads in the Black Hills just south of the Lead-Deadwood area. It flows east, passing into the plains just north of Rapid City. From this point to the mouth, Elk Creek flows over deposits of marine shales. A water sample collected during June contained 2.0 µg/l of mercury, or a load of 1.2 lbs/day. This was the highest concentration of mercury observed in any stream not influenced by Homestake discharges and resulted from leaching of mercury adhering to suspended sediment particles. Subsequent water samples collected during July did not contain detectable mercury. The benthos community of Elk Creek reflected the influence of domestic waste or agricultural drainage and intermittent flows; however, the flesh of fish collected from this stream contained only 0.05 ppm of mercury.

The levels of mercury contained in the above streams during periods of runoff do not cause high mercury concentrations in resident fish. Fish collected from Angostura Reservoir, the Cheyenne River at Wasta, and from tributaries, including French Creek, Battle Creek, Rapid Creek, and Elk Creek, all contained mercury concentrations less than half the FDA guideline. The biotic communities of each of these streams, except Rapid Creek, reflected the presence of organic wastes. No adverse effects of siltation or toxic substances were detected in any of the streams in this portion of the Cheyenne River drainage.

Nutrients made the Cheyenne River at Wasta and its upstream tributaries extremely fertile. This over-enrichment affected the aquatic life community. Benthos samples collected near Wasta contained high densities and low variety of organisms. This reflected the presence of organic wastes and the absence of siltation or toxic materials.

The farthest upstream station in the Belle Fourche River drainage system was located on Spearfish Creek downstream from Bridal Veil Falls, near Maurice. Here the benthos consisted mostly of pollution-sensitive mayflies, caddisflies, and stoneflies, with large numbers of black fly larvae of intermediate tolerance, indicating little or no pollution. Two unfiltered water samples from this station, collected during a rainstorm, contained 0.5 and 2.3 µg/l of mercury. The wide variation in results indicates that the mercury was attached to sediment being washed into the stream, possibly from tailings piles located upstream along tributaries to Spearfish Creek. Brook trout and brown trout collected from this stream contained no detectable mercury, indicating that high mercury concentrations occur infrequently in Spearfish Creek.

The Redwater River, which receives drainage from Spearfish Creek, drains into the Belle Fourche River near Belle Fourche, South Dakota. The diversity of pollution-sensitive benthos indicated minimal damage from siltation or toxic materials. Trout collected here did not contain detectable mercury concentrations and the flesh of white suckers and creek chubs had mercury concentrations of less than 0.20 ppm. However, northern redhorse suckers collected from the Redwater River had moderate mercury concentrations in their flesh, averaging 0.29 ppm; and carp had an unacceptably high mercury concentration in their flesh, averaging 0.58 ppm. Apparently these fish migrated into the Redwater River from contaminated waters downstream.

The Belle Fourche Reservoir receives water diverted from the Belle Fourche River below the Redwater River confluence. Fish collected from this reservoir all contained mercury concentrations less than one-half the maximum limit recommended by FDA.

A water sample collected from the Belle Fourche River near Fruitdale during the June period of high runoff contained 0.4 µg/l of mercury. In subsequent samples, collected during normal streamflow, mercury was not detected. No arsenic was detected in the stream, even during periods of high streamflow. The Belle Fourche River at this location was biologically fertile, but not polluted. Benthos in this reach consisted of a variety of primarily pollution-sensitive organisms, including burrowing mayflies, and low numbers of intermediate and tolerant forms. All fish collected from this river reach contained mercury concentrations less than 0.5 ppm. The highest mercury concentration detected was 0.29 ppm in one fish, a goldeye.

Whitewood Creek at the U. S. 85 bridge at Pluma generally contained low levels of mercury. One sample collected June 9 during a rainstorm contained 1.7 µg/l of mercury, apparently the result of leaching from sediment washed into the stream. Arsenic was present in relatively low levels of 12 to 13 µg/l. Other metals were present as the result of the known mineralization in rocks upstream of this station. A sediment concentration of 0.54 ppm mercury is consistent with the mineralized nature of the drainage basin. The stream supported the greatest variety of benthic organisms encountered during the survey, including five stonefly genera, four mayfly and caddisfly genera, and many other forms in moderately high numbers. Fish collected from this reach (brook trout, white suckers, and longnose dace) did not contain detectable mercury concentrations.

R. W. Warner

Deadwood Creek above Deadwood generally contained low levels of mercury. And then in the next sentence there is another typographical error. It should read: One sample collected June 9 during a rainstorm contained 1.4 µg/l of mercury, similar to levels in Whitewood Creek on the same day. These high levels result from erosion of sediment from the known mineralized area. During the three days of sampling in June 1971 the stream carried an average mercury load of 0.04 pounds per day. Sediment contained 0.12 ppm mercury. Arsenic was present in low concentrations of 8 to 12 µg/l. Other metals were present in levels slightly higher than those in Whitewood Creek. The stream supported a diverse assemblage of 23 kinds of benthic animals, including many pollution-sensitive forms. Brock trout collected from Deadwood Creek contained no detectable mercury.

The quality of City Creek at Deadwood was similar to that of Deadwood Creek and Whitewood Creek. Metals were present, but did not appear to harm the stream biota. Qualitative biological sampling of City Creek revealed the presence of many pollution sensitive forms.

Flow in Gold Run consisted of discharge from the Homestake Mining Company's sand dams and sewage from the town of Lead. The stream contained extremely high concentrations of suspended sediment. Mercury concentrations in the water ranged from 3.8 to 12.0 µg/l. Cyanide was present at levels from 0.5 to 3.6 mg/l. Arsenic levels of 138 to 1000 µg/l were present in the stream, as a result of oxidation of vast amounts of arsenopyrite in the Homestake tailings slurry. The stream contained 0.89 mg/l of copper and 1.15 mg/l of zinc in one sample. No aquatic organisms inhabited Gold Run. The concentrations of cyanide, mercury, arsenic, and suspended solids detected in this reach were each sufficiently great to be independently destructive to fish and benthos. Therefore, it was not possible to attribute the destruction of aquatic biota to a single constituent contained in the Homestake Gold Mill effluent. All were damaging.

The Homestake Mining Company slime plant effluent is discharged into Whitewood Creek immediately upstream from Deadwood Creek. Mercury in this effluent ranged to concentrations as high as 57 µg/l, as the result of leaching of mercury from the ore fed to the mill. No mercury was used in the process at the time. Cyanide used in the leaching process was escaping in the sluiced waste at concentrations of from 3.8 to 9.9 mg/l. Arsenic was abundant in the effluent samples, with concentrations ranging to 1,000 µg/l.

Whitewood Creek at the Deadwood Rodeo Grounds was in marked contrast to the quality of the stream upstream from Gold Run, and to Deadwood and City Creeks. The creek was a leaden-gray stream of sand and slimes, resulting from the discharge in the two Homestake effluents of 2,735 tons per day of suspended solids, containing 9.5 tons per day of arsenic in the form of arsenopyrite. The suspended solids concentrations in Whitewood Creek, according to applicable stream standards, should be less than 90 µg/l. This indicates that the maximum allowable load of suspended solids in Whitewood Creek from all natural and artificial inputs can be no greater than 7.3 tons per day at a flow of 30 cfs. Therefore, the discharge of Homestake Mining Company effluent is approximately 375 times greater than the maximum permitted solids load in Whitewood Creek at 30 cfs. To meet existing standards, there must be a reduction of at least 99.7 percent of the present solids discharge from the Homestake Mining Company. Mercury concentrations ranged from 2.1 to 8.0 µg/l, for an average mercury load during the June sampling of 2.5 pounds per day. Tributary flow added 0.15 pounds per day of this total load, with the remainder contributed by the leaching of mercury contained in the ore fed to the Homestake Mill. Additional mercury remains attached to the sediment discharged to the stream, but is available for leaching during high stages and for methylation and uptake by downtream biota. Cyanide concentrations in Whitewood at the Deadwood Rodeo Grounds ranged from 0.50 to 1.1 mg/l, for an average load of 312 pounds per day during the June sampling. All the cyanide was from the Homestake mill. Arsenic was present in the water at concentrations of from 230 to 1700 µg/l or 82 to 293 pounds per day. The stream carried a load of 72 pounds per day of copper and 241 pounds per day of zinc on June 10, 1971. Of this, less than 0.6 pounds per day of copper and 4 pounds per day of zinc were contributed by tributary inflow. The remainder was from the Homestake effluents. No aquatic organisms inhabited this station, as the result of the high concentrations of cyanide, mercury, arsenic, and suspended solids.

Stream sediment contained 0.18 ppm of mercury, which is approximately one-third of the concentration of 0.57 ppm of mercury in the ore fed to the Homestake Mill. The remainder of the mercury is leached from the ore during the milling process.

MR. STEIN: Mr. Warner, I think this may take a little longer than we anticipated. We have some coffee outside. Let's take a 10-minute break, then we will resume.

(RECESS)

MR. STEIN: Let's reconvene.

MR. WARNER: Water quality conditions in Whitewood Creek at downstream stations did not improve materially. Mercury concentrations remained high, although the load decreased as the result of adsorption on the tailings solids Arsenic concentrations increased downstream to a range of 1270 to 1900 µg/l at the mouth. Cyanide concentrations were 0.58 mg/l downstream from Whitewood and 0.16 mg/l at the mouth, near Vale. Copper, iron, and zinc were present. The stream supported no aquatic life downstream from the Homestake discharges. The destruction of all aquatic life in this stream is directly attributable to the high concentrations of cyanide, mercury, arsenic, and suspended solids resulting from the two Homestake discharges.

Horse Creek and Bear Butte Creek are the major tributaries to the Belle Fourche River in the vicinity of the mouth of Whitewood Creek. Water samples collected from these two streams during June contained low mercury concentrations, apparently as the result of leaching of decomposed shale washed into the stream. Neither sample contained detectable arsenic concentrations. Samples collected during July, at normal streamflow, did not contain detectable mercury concentrations.

The effects of the Whitewood Creek inflow were evident in the Belle Fourche River downstream from the Whitewood Creek and Bear Butte Creek confluence. Suspended sediment, resembling Homestake tailings, was clearly visible in the water, with a large amount of settled solids covering the stream bottom. Mercury concentrations in the stream during June were 0.6 µg/l, or 3.0 pounds per day. The arsenic concentration was approximately 0.5 mg/l. Arsenic levels were sufficiently high to be a source of chronic toxicity to aquatic organisms. The cyanide concentration was less than the detection limit of 0.02 mg/l. Suspended solids settled on the river bottom, destroying habitat. The benthos in this reach consisted of little variety of organisms in a very low density of only 30 per square foot. The flesh of fish collected from this reach contained moderate-to-high concentrations of mercury, some of them bordering on 0.5 ppm.

Water samples were collected from the Belle Fourche River north of Elm Springs. As previously noted, the June sampling was conducted during a period of high but declining stream stages. Flow time between Bear Butte Creek and Elm Springs was estimated at one day. As a result, the net flow measured at the downstream station was much larger than the flow at the upstream station. This higher flow was responsible for the resuspension of previously-deposited Homestake tailings solids. A portion of the metals concentration contained in these tailings solids was leached into the stream, resulting in an increase in metals load in the downstream direction. The June samples at Elm Springs contained 2.8 µg/l of mercury, or 19.7 pounds per day, in contrast to the load of 3.0 pounds per day at the upstream station. This instream increase in mercury load, attributable to the resuspension of tailings, indicated the importance of removing mercury-laden tailings solids from the streambed and banks. Otherwise, the material will continue to be a source of mercury for years. The zinc concentration in the Belle Fourche River north of Elm Springs was double that of the river near Bear Butte Creek and also resulted from resuspension of the previously-deposited Homestake tailings solids.

Water samples collected in June from the Cheyenne River downstream from the Belle Fourche River contained 0.8 µg/l of mercury, or 15.1 pounds per day. Arsenic levels were approximately 0.2 mg/l, or four times the level which constitutes grounds for rejection as a domestic water supply. Thus the Homestake discharges render the entire stream unsuitable as a source of domestic water supply. Samples collected during July, during normal streamflow, did not contain detectable mercury in solution. A moderate degree of siltation had occurred in the Cheyenne River near Plainview. Here the benthic types were similar to those at Wasta, but the density of organisms decreased by 75 percent. Some of the fish collected here were heavily contaminated with mercury. Sauger flesh had a mercury concentration of 0.82 ppm, the highest encountered in the Cheyenne River system outside of Oahe Reservoir. Carp and channel catfish were also contaminated by high mercury concentrations.

A sediment sample from the Cheyenne River near Plainview contained 0.83 ppm of mercury. This concentration reflects the previous use of mercury in the Homestake amalgamators and is indicative of the deposition and resuspension which occurs in the travel of tailings from the Lead-Deadwood area to Oahe Reservoir.

Samples of fish collected from the Cheyenne Arm of Oahe Reservoir by the U. S. Fish and Wildlife Service and were analyzed by the Kansas City office of the EPA. These fish generally contained high mercury concentrations, many of which exceeded the guideline. Mercury concentrations exceeding 0.5 ppm were detected in the flesh of northern pike, walleye, sauger, white bass, black crappie, channel catfish, freshwater drum, shovelnose sturgeon, carpsucker, carp, and bigmouth buffalo. Mercury concentrations in fish flesh were highest in the upper Cheyenne Arm of Oahe Reservoir, near the river mouth, with over 25 percent of all samples exceeding the guideline. Mercury concentrations in fish flesh generally decreased with distance from the river mouth. Mercury was not detected in water samples collected from the Cheyenne Arm, but bottom muds contained excessive mercury. The mercury concentrations in muds were highest in the upper Cheyenne Arm near the Cheyenne River mouth, with generally decreasing concentrations toward the main reservoir body. The levels were highest in mid-channel and lower near shore. This indicates that mercury-laden sediment continues to be transported into Oahe Reservoir by high streamflow in the Cheyenne River. The sediment then deposits in Oahe Reservoir and contaminates fish.

MR. DICKSTEIN: Thank you, Mr. Warner.

Our next speaker is Jim V. Rouse of the Division of Field Investigations, Denver Center.

Mr. Rouse.

JIM V. ROUSE, GEOLOGICAL ENGINEER
DIVISION OF FIELD INVESTIGATIONS
DENVER CENTER, EPA - REGION VIII
DENVER, COLORADO

MR. ROUSE: Mr. Chairman, conferees, ladies and gentlemen.

I am Jim Rouse, Geological Engineer with the National Field Investigation Center of EPA, Denver. I will be reading additional portions of the"Report on Pollution Affecting Water Quality of the Cheyenne River System, Western South Dakota." This is the report just mentioned by Mr. Warner.

Many millions of tons of tailing solids have been discharged by the Homestake Mining Company during the history of the company's Deadwood-Lead operation. At least 9 million tons of tailings have been discharged since the completion of Oahe Reservoir. The discharge of this sediment has completely changed the hydrologic regime of the Whitewood Creek-Belle Fourche River-Cheyenne River system. Much of the material was deposited along the various streams, especially the lower reaches of Whitewood Creek and the Belle Fourche River in the first few miles below the mouth of Whitewood Creek.

A mineral of the amphibole group was common at all stream stations downstream of the Homestake discharge, but was not found at those stations upstream of the Homestake discharges. The same mineral was common in the deposits of buried tailings. The amphibole was also observed in sediment from the Cheyenne River Arm of Oahe Reservoir. Optical mineralogy techniques were utilized to determine that the amphibole was the mineral cummingtonite, which is reported to be a major constituent of the Homestake ore.

A limited amount of core drilling was performed, to verify the presence of deposits of previously-discharged Homestake tailings. In one case, drilling in an abandoned stream meander 7 miles east of Vale disclosed that old Homestake tailings had been deposited, causing the stream to change its course. The meander contained up to 9 feet of tailings at the holes drilled, for an estimated total volume of 30,000 cubic yards of tailings deposits at this one site. Assay of the buried material indicated that this one deposit contains approximately 200 pounds of mercury. Several other abandoned meanders were observed in the same area.

In lower reaches of Whitewood Creek the flood plain is underlain by up to 10 feet of material, which appears to be stamp-mill tailings deposited during the early milling days in the Lead area. A sample was found to contain 1.2 ppm of mercury. If this is representative, each cubic yard would contain 1.8

grams of mercury. At the Whitewood Creek bridge downstream from Crow Creek, these deposits extend for at least one-quarter of a mile along the stream, with an average width of 100 yards. This section may contain 290 pounds of mercury.

Groundwater samples were collected from auger holes in the tailings deposits and from nearby wells drawing water from the alluvium. Solids samples were also collected from the auger holes at various depths. The buried tailings solids contain mercury in concentrations of from 2 to 4 ppm by weight. Those solids beneath the water table generally contain less mercury than those above the water table, indicating a leaching of mercury by groundwater has occurred and is continuing. This conclusion is supported by data on mercury concentrations in the groundwater. A sample of groundwater from the tailings deposit contained 34 µg/l of mercury, nearly seven times the recommended PHS limit of 5 µg/l for drinking water. A sample of groundwater from alluvium underlying the tailings solids contained 1.8 µg/l, which is 69 times the background mercury levels. Water samples from some wells along the stream contain mercury at levels exceeding background concentrations, but much less than 5 µg/l. These concentrations correlate with distance from the stream and buried tailings deposits.

While the concentrations of mercury in the groundwater are generally less than the proposed PHS standard, they do indicate a continuing degradation of quality as a result of the buried tailings solids. Groundwater conditions are such that mercury from these deposits will continue to enter the surface streams via groundwater inflow.

Samples from four domestic water supply wells which draw water from the alluvium along the streams were analyzed for arsenic. No arsenic was detected, indicating that arsenopyrite in the buried tailings is not being leached to the groundwater. However, four samples is not sufficient to insure that some arsenic pollution is not occurring.

The deposits of buried tailings solids are of importance to future water quality. The rivers are eroding the deposited material. Thus the deposits will gradually be moved downstream to Oahe Reservoir. This effect will be accelerated once discharge of solids from Homestake has ceased. At that time the affected streams will initiate a period of downcutting, to adjust to a new set of hydrologic conditions. The buried tailings deposits will continue to be a source of sediment and metals pollution unless they are removed or stabilized.

Additional information is required on the location, extent, and composition of the buried deposits. The needed information can be secured by a combination of remote-sensing technology and an exploratory drilling program.

Presently research is in progress to develop techniques for recovery of mercury from sediments. If the techniques prove feasible, they should be employed to recover the mercury contained in the buried tailings deposits. If the techniques are infeasible, the deposits should be stabilized pending later technical developments.

A sanitary district has been formed to abate pollution from the discharge of sewage from the towns of Lead and Deadwood and the Homestake Mining Company discharges. A system has been designed to collect the Homestake wastes and the sewage and transport it via pipeline to a large tailings pond-oxidation lagoon to be constructed on Centennial Valley. An application for a construction grant was submitted to the Environmental Protection Agency on April 8, 1971. The schedule of construction calls for completion of the facility by November 1973.

There has been much local opposition to the project on the basis of damage to scenic values and groundwater resources. The project will visually degrade the valley site. However, the overall environmental impact will be less than the existing situation, in which miles of stream are now rendered gray and lifeless and a health hazard exists. The planned facility should not damage the groundwater resource if constructed as planned. The proposed sanitary district project will be a marked improvement over the existing situation.

The present health hazard resulting from toxic materials in the Homestake effluent must be abated. Personnel of Homestake Mining Company and EPA investigated alternative techniques which could be utilized for an interim pollution control measure, Primary considerations in the selection of interim control measures were rapidity of construction and control of sediment discharge.

Whitewood Creek flow is highly variable, with reported discharges in excess of 5,000 cfs. During eight months of the year the flow is less than 30 cfs and consists largely of sewage from Lead and Deadwood and of Homestake Mining Company tailings slurries. Substantial water quality improvement would result from construction of a system to divert and impound the Whitewood Creek flow, especially when such flow is less than or equal to 30 cfs.

May we have the second slide, please. This is the Figure 2 from the report.

A suitable diversion site is available on Whitewood Creek downstream from the town of Whitewood. As you see on the slide, Crow Creek, a small intermittent stream, almost intersects Whitewood Creek before turning and flowing parallel to Whitewood Creek. A small diversion canal could be constructed through the intervening ridge and a simple diversion dam constructed across Whitewood Creek. Flows less than 30 cfs would then be diverted to Crow Creek and the tailings solids settled in an impoundment. Four dam sites were investigated, with Site D, the most downstream site, found to offer the greatest advantages. Clarified water with no silt would overflow the impoundment, continue down Crow Creek and rejoin Whitewood Creek. Flows in excess of 30 cfs would overflow the Whitewood Creek diversion dam. The proposed project would remove approximately 80 percent of the pollutants carried by Whitewood Creek. The project as envisioned would be of simple construction and could be operational in a short time. Following completion of a permanent treatment facility, it will be necessary to stabilize and rehabilitate the impounded tailings in the temporary facility to prevent erosion to Lower Crow Creek and the downstream waterways.

This project as outlined here was discussed with Homestake officials April 16, 1971.

Homestake Mining Company reports encountering inflated land prices in their discussions with landowners in the Crow Creek area. Because the company does not have the right of condemnation, the practice of asking inflated prices for land in the project area threatens the establishment of the interim tailings pond which was designed to significantly reduce the existing health hazard caused by Homestake's discharge. The Crow Creek diversion and tailings pond is a necessary and technically feasible interim control measure pending the completion of the sanitary district facilities.

At this point we offer the following summary and conclusions.

1. Streams draining areas of placer mining and mineral deposits in the Black Hills do not contain significant concentrations of mercury or arsenic during normal runoff. Certain of the streams examined contained high concentrations of mercury during infrequent periods of high runoff. Fish in these streams contain mercury at concentrations less than the FDA guideline of 0.5 ppm. Streams draining areas of marine shale contain detectable quantities of mercury during infrequent periods of high runoff, but do not contain detectable mercury during normal stream flow. Fish in these streams contain mercury at levels generally less than the FDA guideline of 0.5 ppm.

2. The benthos communities of Spearfish Creek, Redwater River, Belle Fourche River at Fruitdale, Cheyenne River at Wasta and French, Battle, Rapid and Elk Creeks were not damaged by siltation or toxic materials. The flesh of fish collected from all of these stream reaches, with the exception of Redwater

River, contained mercury at concentrations less than the FDA guideline. Redwater River carp contained mercury in excess of FDA standards.

3. Although Homestake Mining Company discontinued the use of mercury in their milling process in December 1970, the plant effluents still contain approximately 2.35 pounds per day of mercury. This is a misprint in the prepared report, which gives 2.5. Again, the corrected figure is 2.35. This results from the leaching of mercury contained in the ore fed to the Homestake mill. A major portion of the discharged mercury is adsorbed by sediment in Whitewood Creek. From 0.1 to 0.5 pounds per day of mercury is transported into the Belle Fourche River during periods of low flow. Larger amounts are transported during high stream flows.

4. Analyses of effluents discharged during June 1971 showed the Homestake Mining Company to be adding daily loads of 312 pounds of cyanide, 240 pounds of zinc, 72 pounds of copper, and 2,735 tons of suspended solids to Whitewood Creek. The suspended solids discharge is approximately 375 times greater than the loading permitted under the applicable water quality criteria at a stream flow of 30 cfs. The tailings solids include a load of 9.5 tons per day of arsenic in the form of arsenopyrite, an arsenic-iron sulfide. The arsenopyrite is

oxidized, resulting in arsenic concentrations in the Cheyenne River which are four times greater than the U. S. Public Health Service water supply criterion.

5. Whitewood and Deadwood Creeks, upstream from the Homestake discharges, contain high levels of mercury during runoff periods, but lower levels at other times. Flesh of fish from these streams does not contain detectable mercury concentrations. Deadwood and City Creeks, as well as Whitewood Creek upstream from Gold Run, were inhabited by diverse communities of aquatic organisms, including a predominance of forms sensitive to pollution. Whitewood Creek from Gold Run downstream to the mouth was severely damaged by discharges from Homestake Mining Company. No aquatic organisms were found in this stream reach. Concentrations of cyanide, arsenic, mercury, and suspended solids were each sufficiently high, independently or in concert, to destroy the biota of Whitewood Creek. Damage extended into the Belle Fourche River downstream from the mouth of Whitewood Creek. Siltation and high arsenic concentrations in the Belle Fourche reduced the number and variety of benthos. Fish from this reach of the river contained high mercury concentrations.

6. Previously discharged Homestake tailings solids have been deposited along Whitewood Creek and the Belle Fourche

and Cheyenne Rivers. These solids are eroded and leached during high stream flows. Buried deposits of tailings solids occur in abandoned river meanders, chiefly along the Belle Fourche River. Leaching of mercury from such deposits contaminates groundwater as well as surface streams. The groundwater is used as a source for domestic supply. Large quantities of mercury are contained in the buried tailings. After cessation of the discharge of solids from Homestake, the deposits will be eroded by surface streams as the streams adjust to a new hydrologic regime. Research is currently under way to develop methods of recovering mercury from sediments. The buried tailings also contain large quantities of arsenopyrite, an arsenic-iron sulfide,which may be leached to surface streams or groundwater.

7. Deposits of Homestake Mining Company tailings occur in the Cheyenne River Arm of Oahe Reservoir. Mercury from these deposits contaminates the flesh of fish in the Cheyenne River Arm of Oahe Reservoir at levels often exceeding the FDA guideline.

8. Plans are under way for construction by the Lead-Deadwood Sanitary District of a tailings pond-sewage lagoon which will treat raw sewage from Lead and Deadwood as well as the Homestake Mining Company effluents. The facility is scheduled for completion in November 1973.

9. Interim tailings pond sites are available which would result in a reduction of about 80 percent of the pollution carried by Whitewood Creek pending completion of the sanitary district facilities.

It is recommended that:

1. The Lead-Deadwood Sanitary District proposed treatment facility at Centennial Valley,designed to treat domestic sewage and Homestake tailings, shall be constructed and in operation by November 1973. Progress schedules as specified by the Homestake Mining Refuse Act Permit Application are to be met.

2. Pending completion of the sanitary district facility, Homestake Mining Company shall construct and operate an interim tailings pond to control the continuing mercury pollution from Homestake and substantially reduce the cyanide, arsenic, and tailings solids in Whitewood Creek. If the interim facility is not completed and operating by July 1, 1972, Homestake shall be cited under the provisions of the River and Harbor Act of 1899 for discharging toxic materials and solids to the Cheyenne River system.

3. The location and composition of buried tailings materials along Whitewood Creek, the Belle Fourche River, and the Cheyenne River shall be carefully ascertained and fully

documented. Toxic materials shall be recovered as the technology becomes available. Pending the development of recovery techniques, the deposits should be stabilized to prevent their reentry into the hydrologic system.

4. Arsenic concentrations in wells drawing water from alluvium downstream of the Homestake discharges shall be determined to ascertain whether these sources are acceptable for domestic or agricultural water supply uses.

5. The South Dakota Department of Game, Fish, and Parks shall assure that the excessive concentrations of mercury in fish of the Cheyenne River system are known to the public, such notification to include recommendations of nonconsumption of fish. Commercial fishing in the Cheyenne Arm of Oahe Reservoir shall be prohibited.

6. A complete inventory of the location and composition of abandoned tailings piles in the area north and west of Lead shall be conducted by the State of South Dakota. The State shall take appropriate measures to assure that adverse effects on water quality and aquatic life resulting from residual toxic materials contained in these tailings shall not occur. The State assure that the tailings are controlled in accordance with the best available technology.

7. Water quality standards shall be established for

Whitewood Creek and Deadwood Creek, including an implementation plan for abatement of existing pollution.

MR. STEIN: Thank you.

Are there any comments or questions? Why don't you both wait.

MR. GRIMES: Mr. Stein, I assume that a corrected copy of this report will be made available to the conferees in short order?

MR. STEIN: Do you have a--

MR. DICKSTEIN: We have duplication equipment available.

MR. STEIN: I have a corrected copy here, don't I?

MR. DICKSTEIN: No, there are a couple of paragraphs inserted quite recently, and I don't believe you have the corrected copy.

MR. STEIN: When will that be made available?

MR. DICKSTEIN: It should be available this afternoon.

MR. STEIN: Can we have that when we come back from lunch?

MR. DICKSTEIN: I don't see any reason why we can't.

MR. STEIN: Thank you.

I have a couple of clarifying questions.

On page 33, I believe maybe Mr. Rouse gave this, you talk about research and techniques to recover mercury from sediments. If the techniques are feasible, deposits should be stabilized. Do we know how to stabilize those deposits?

MR. ROUSE: Yes, sir, by a technique such as rip-rapping, temporary measures pending the development of technology.

MR. STEIN: Oh, you say pending. Do you have some kind of a notion how long you should let the research go on and not stabilize?

What I am getting at is this. In other areas you have talked about interim measures. I would like to know whether you have them on here, how long you let this go, or how long you are going to figure something is going to stabilize?

MR. ROUSE: Much of the research with which I am familiar is scheduled for completion within a two-year period.

MR. STEIN: Do you think we can wait this two years?

MR. ROUSE: I think we have to wait on some of them until we locate where the sources are. This is one of the recommendations, of course, is to determine the location of the material. If you find deposits of tailings solids which are being actively eroded at this time, they should be stabilized as located.

MR. STEIN: In other words--let me see if I can get your recommendation--what you are saying is they are trying to define where these sediment deposits containing mercury are. What you are proposing is as soon as we find it, measures be taken to stabilize these right away pending the development of a more permanent technique. Is that your proposal?

MR. ROUSE: If such deposits are actively being eroded.

MR. STEIN: Right. Are there any methods other than riprapping?

MR. ROUSE: Yes, there are a number of fairly conventional techniques.

MR. STEIN: Will you try to enumerate them?

MR. ROUSE: It is generally protecting the stream bank from erosion by methods, riprap,covering with impervious material. It would depend on the individual situation. Pilings.

MR. STEIN: In other words, they would all achieve the same result; it would be a riprap or a substitute for it such as covering of pilings? Very well.

One more question. You talked about the Crow Creek interim plant and the high cost of the land. I just put this discussion out--I don't know whether you can answer it--but someone might consider this before all these statements are in: Does that sanitary district have the right to condemn the land for this purpose?

MR. ROUSE: That I will have to refer to the lawyers.

MR. STEIN: All right.

The last recommendation you make, you say"water quality standards be established for Whitewood Creek and Deadwood Creek, including an implementation plan." By whom are the water quality standards to be established?

MR. ROUSE: I understand this is the responsibility of the State.

MR. STEIN: All right. I think that should be made clear.

I think you have an important thing here included by reference. In your first recommendation you say that the Lead-Deadwood works be constructed and in operation by November 1973 and progress schedules as specified in the Refuse Act permanent act are to be met.

I wonder if we could have those progress schedules and interim dates for the purpose of this conference, because I think we will need something more definite than just a reference. Can you give us that now?

MR. ROUSE: Yes.

MR. STEIN: All right.

MR. ROUSE: Some of the pertinent dates include February 1, 1972, plans completed; April 15, 1972, contract let; June 1, 1972, start construction; October 1, 1972, construction completed; November 1, 1972, facilities in use.

MR. STEIN: Thank you.

Are there any other comments or questions?

MR. DICKSTEIN: Mr. Stein, I have several questions.

You mentioned the high runoff in your early spring sampling. Was this considered normal or is this unusual for this particular year?

MR. ROUSE: The period May and June is normally the high runoff period. However, the runoff this past June was higher than all but one year in the period 1966 through the present. There was a higher flow year in 1967, but this is much above the normal situation.

MR. DICKSTEIN: O. K. Now, the stream flow during the summer sampling,was this normal or abnormal, in your opinion?

MR. ROUSE: The July sampling?

MR. DICKSTEIN: Yes, sir.

MR. ROUSE: It was slightly high, but not nearly so high as that in June, not nearly as much above the normal.

MR. DICKSTEIN: O. K. I have just one more question.

Assuming the land on the interim structure can be purchased, how long will it take to put the structure in, in yourbest judgment?

MR. ROUSE: That is a function of the climatic conditions, but we feel the July 1 date is a reasonable date.

MR. DICKSTEIN: What is the total time, one month, two months, five months, six months, in your best judgment?

MR. ROUSE: The construction time is approximately four to five months.

MR. DICKSTEIN: Thank you.

MR. STEIN: When does the construction season start in this area?

MR. ROUSE: Well, after the ground thaws. (Laughter.)

MR. STEIN: I know that. I think what this leads to is the question that we need to ask here if you are going to have a completion of a plant in 1973. The earliest you can have the interim structure in is summer 1972? Is that right?

MR. ROUSE: Yes.

MR. STEIN: All right. Now, when will the construction have to get started to do that during the year of 1972? And then we have to work backwards from that to determine when the land will have to be acquired to see if this is a feasible suggestion.

MR. ROUSE: No construction can really be carried on during the wintertime.

MR. STEIN: Yes.

MR. ROUSE: However, depending on the chances of weather, you should have a couple of months to acquire the land, and then you would have construction begin in April or early May of the following year.

MR. STEIN: In other words, this would give protection for one year until the completion 1973 date. Have you got an estimate of what this would cost to get the land and put up the structure?

MR. ROUSE: We have estimated the construction cost, exclusive of land, at $250,000 to $300,000. Land costs are very difficult to estimate. The appraised value of the land is probably in the neighborhood of $100 per acre.

MR. STEIN: Well, we can get that. But I think the question that we raise is what you are suggesting is buying something for $250,000 construction cost plus land cost to provide an interim solution that is going to work about a year, is that right?

MR. ROUSE: That is true if you assume the final facility is completed by November 1973.

MR. STEIN: Right.

MR. ROUSE: Of course any slippage in that date--

MR. STEIN: Yes, right.

Any others? Yes, Doctor.

MR. GRIMES: Go ahead.

DR. HAYES: Mr. Chairman, I understood the gentleman to say he felt this could be constructed, that is the interim facility proposed in point 2, by July 1, 1972?

MR. ROUSE: Yes, sir.

DR. HAYES: And that is with the conditions which we would normally anticipate in South Dakota?

MR. ROUSE: Yes.

DR. HAYES: I would like to at least propose to the conference that is a matter of debate. I don't really think it can be. I am not an engineer or a construction man either, so I hesitate to say, but anything I have ever had done for me in South Dakota never followed that kind of a schedule. (Laughter.)

MR. GRIMES: Mr. Stein.

MR. STEIN: Yes.

MR. GRIMES: I think that the conference should direct its attention also to the fact that if the interim measures are put in that after they have served their purpose that this reach of Crow Creek is highly contaminated also, that the sediments that occur during that period of time should be considered by this body.

MR. STEIN: Yes. I think these are all very pertinent points. It seems to me again--and I know you don't have Charlie Carl with you today, but I have worked with him on these construction projects here for maybe a quarter of a century and I appreciate what you say, Doctor, about the problems we have.

But it would seem to me that if we are going for this interim measure we had better devise a plan where we are going to get site acquisition almost immediately and begin to go into construction if you are going to possibly make it the day after the thaw sets or the first construction date next spring.

Do you have a comment on that other situation, if we use this for a year that we may have an area contaminated now that is relatively free of contamination at the present time?

MR. ROUSE: Well, as we state on page 35 of the report, it will be necessary to stabilize the material after completion of usage of the project.

MR. STEIN: And that is an added cost?

MR. ROUSE: Yes, a very minor cost with the existing technology; in other words, covering material with a few inches of soil from the site, and so on.

MR. STEIN: How many miles is that?

MR. ROUSE: The impoundment area is less than a section area of land, about a quarter of a section of land.

MR. GRIMES: The impoundment area for what?

MR. ROUSE: For the Crow Creek.

MR. STEIN: Is that the only area you are going to have to cover?

MR. ROUSE: Yes.

MR. STEIN: All right.

MR. DICKSTEIN: Mr. Rouse, is there any chance that the land might be enhanced by this operation?

MR. ROUSE: Well, it is now a fairly steep area and you will, of course, have a flat upper surface of the pond when you cover it with the soil from the site. The vegetation should be the same as that currently on the site. You will have some subirrigation so the moisture situation will be better than the existing conditions. Groundwater conditions should not offer any problem, as it is quite a tight shale area.

MR. HANTEN: Mr. Chairman.

MR. STEIN: Yes, go ahead.

MR. HANTEN: Would there be a possibility of groundwater leakage of materials?

MR. ROUSE: No. The bottom of the area would be highly impervious. We would not have a net flow movement down. If you constructed the dam adequately in accordance with good engineering practice you would not have movement laterally from the area. If you cover the area with local soils, these soils are very impervious and would not have water coming in contact with the materials.

MR. STEIN: Doctor?

DR. HAYES: Mr. Chairman, at the risk of being out of order, and I hope I am not, I think we are trying to get into some areas which are predicated on the statement or at least the assumption that--according to your statement on page 34, which I am going to read--"The present health hazard resulting from toxic materials in the Homestake effluent must be abated."

My impression was, and I go back to the Governor's charge in his letter and again this morning, that our conference and participants would at least help us to determine whether or not there is an immediate mercury hazard toxic to man or whether it is a potential hazard. I personally am of the opinion, and I will state it later, that there is a potential hazard. I think that could be documented fully.

I have the immediate and glaring question before me now, as with a year ago, whether or not there is an immediate toxic hazard to man from mercury. I realize that cyanide is another matter. I don't want to get into that until later. But I think that perhaps the other participants, the folks here from the FDA, and the other agencies, will help us shed some light on that and I would like to, if we may, progress to that point and then go back to this one if possible.

MR. STEIN: Yes, that will be held later. I think that is the key point on the hazard we have here in mercury.

I would like to just indicate what we have done in other areas of the country. I think where we had an actual hazard or where it was felt we had an actual hazard we would employ a very rapid technique and get into court immediately under the 1899 Act. Where there was a potential hazard we used either negotiation or a conference technique. However, in all the cases in other parts of the country I think it has been agreed--and as I read this report it is based on the same assumption--that we should make every effort to reduce discharges of mercury into the environment to the irreducible minimum. Because we do know how long-lived it is, and the change of metallic mercury to methylated mercury over a period of time is not presenting an actual acute hazard but rests with a potential hazard. At least that has been our theory with mercury because of the propensity of mercury to change its form and then be available for uptake by food organisms that man eats. The idea is to keep this down as much as possible.

I think, Doctor, if we come to this, your question is directed at how much time we have to deal with this and then roll this back as far as we can.

Are there any other comments or questions? Yes.

MR. HANTEN: I have one point that I would like to have clarified with regard to the trout that were collected in the upper Whitewood Creek area above the area of pollution from Deadwood-Lead Homestake--what size these fish were, whether they were native or possibly stocked?

MR. DICKSTEIN: Excuse me, sir, I believe Dr. Hassler will cover this in his discussion.

MR. STEIN: Is that all right or do you want to respond?

MR. WARNER: I think I can answer that.

MR. STEIN: All right. Let's defer that question.

Dr. Hassler, would you take note of that?

Yes.

MR. WARNER: I think the question referred to the specific trout that I collected--

MR. DICKSTEIN: Oh.

MR. WARNER: --and that I should answer that, to Whitewood Creek.

MR. STEIN: All right.

MR. WARNER: These were all brook trout and I assume the State does not stock brook trout. The size range was from 4 to 6 inches and no age or condition factors were determined.

MR. STEIN: I am not sure we have it clear after that. It is your judgment that they were not stocked fish?

MR. WARNER: My guess is that they were not stocked fish because I suspect that the State does not widely stock brook trout.

MR. STEIN: Right. All right.

MR. GRIMES: I hope that you obtained the fish in accordance with the State fishing laws?

MR. WARNER: I have a special permit. (Laughter.)

MR. STEIN: That always happens with these fish and game departments. We can always get special permits to catch wonderful game fish out of season. The trouble is there is always something wrong with the fish that we get.

Are there any other comments or questions?

MR. GRIMES: I have one question too--

MR. STEIN: Yes.

MR. GRIMES: --concerning the proposed interim measures on Crow Creek and also with respect to the stabilization of the sludge along the Whitewood Creek downstream from the discharge from the future Centennial installation.

On the Belle Fourche River and if it goes down that far on the Cheyenne, am I to assume that in the interim the Centennial Valley and the stabilization of these sludge ponds after the Centennial Valley facilities are constructed is the responsibility of Homestake or the sanitary district or are there some other programs to cover this kind of thing?

MR. STEIN: Can you people respond to that?

MR. WARNER: I believe someone else should answer that question.

MR. STEIN: Do you?

MR. DICKSTEIN: It seems to me, just my own gut reaction, that if we can substantiate without a doubt that the material did come from Homestake or the sanitary district that they should be obligated to stabilize the stuff.

MR. STEIN: That question you have raised has been one that has plagued us in various other parts of the country. I think that the conferees and all of us have to carefully consider this question of sediments left in the stream and responsibilities for removing them, but I don't think this is to negate the main thrust of the report. I think we have gotten off. Probably this indicates the strength of every program because we have gotten off on some of these issues, and that is the question that the report states--that there is a significant amount of pollutants coming from a particular source in the river degrading the fish. As a matter of fact, as I read it, just below the main concentration of the source they wipe out all the biota and the fish life and below that the fish life contain contaminants. I think if this is the situation, possibly this is the main thing we have to address ourselves to.

I think we also have to approach this question of whether in fact--and I make no judgment on whether the sediment is in the river, no judgment at this time--the sediments left in the river are going to present a continuing problem. If they do, then the question of responsibility for these is going to be one that we and the State have to approach with considerable care, because I don't think we have many guideposts to find out what to do about that.

But I just suggest, let's do first things first and then work on the other.

MR. GRIMES: As you can see from the gist of my questions, Mr. Chairman, I am concerned about the practicality of the proposals being made. No. 1, I am no lawyer, but I would sincerely doubt the ability legally to bind these interests under retroactive application of law.

Secondly, the cost, who is to do it, the time period are of concern to me.

MR. STEIN: I think all your questions are very pertinent. But again let me make a suggestion to the conferees. My suggestion is to address ourselves, if we possibly can, as an initial step to the termination of any active sources of pollution if we have it. Then if we have other problems, we go to these other problems and see how they can be remedied.

Just to get off this subject, let me give you an analogy of something that we all recognize is a problem--though you may not have that much of it up here, although it is related to mines--and that is the acid mine drainage problem in the East. We all know that is a tremendous problem. Our trouble is assessing responsibility and finding who should be responsible for doing something about it. Now, I don't think we have abandoned mines here, although you have some, and I was delighted in many cases to hear that you didn't have problems from them. That is encouraging news.

I think these are two aspects of any cleanup program: 1) deciding whether something should be cleaned up and 2) just as important is deciding who should do it and whether you can make someone do it.

Are there any other comments or questions?

VOICE: Mr. Chairman, would I be out of

order to ask a question?

MR. STEIN: I don't think we are going to take questions from the floor. I am sorry. I announced that before. However, when you do come up, you can direct your questions and we will be here to answer them. All right? Thank you.

Are there any other comments or questions?

If not, thank you very, very much.

MR. DICKSTEIN: I would like to next call on Dr. Thomas J. Hassler, of Fish and Wildlife Service, North Central Reservoir Investigations, Pierre, South Dakota.

Dr. Hassler.

DR. THOMAS J. HASSLER
FISHERY BIOLOGIST (RESEARCH)
BUREAU OF SPORT FISHERIES & WILDLIFE
NORTH CENTRAL RESERVOIR INVESTIGATIONS
PIERRE, SOUTH DAKOTA

DR. HASSLER: Mr. Chairman, conferees, ladies and gentlemen.

I am Thomas Hassler, Fishery Biologist with the Bureau of Sport Fisheries & Wildlife, North Central Reservoir Investigations, Pierre, South Dakota.

Mr. Chairman, I have the formal report, "Preliminary

Investigation of the Mercury Content in Fish, Sediment and Water in Lake Oahe, South Dakota," which I have given to the recorder. I request that this report be entered into the record as if read.

MR. STEIN: Without objection, this will be done.

(The above-mentioned report follows:)

PRELIMINARY INVESTIGATION
OF THE MERCURY CONTENT
IN FISH, SEDIMENT AND WATER IN
LAKE OAHE, SOUTH DAKOTA

To be presented at The Governors Conference on Mercury and Other Hazardous Materials in the Waters of South Dakota, October 19-21, 1971, as a supplement to the Report on Pollution Affecting Water Quality on the Cheyenne River System, Western South Dakota. Both the original report and this supplement will be included in the proceedings of The Governors Conference, October 19-21, 1971.

NOT FOR PRIOR DISTRIBUTION

Prepared by
Environmental Protection Agency
Office of Water Quality
Region VII
Kansas City, Missouri

October 1971

ACKNOWLEDGEMENT

This report is culmination of a joint Federal and State effort involving personnel from the Environmental Protection Agency, the Bureau of Sports, Fisheries and Wildlife, the South Dakota State Health Department and the South Dakota Department of Game Fish and Parks. Specific contributions include direction of fish collection effort, Mr. Fred June, Bureau of Sport Fisheries and Wildlife, North Central Reservoir Investigation coordination of State of South Dakota input, Mr. Marv Allum, South Dakota State Health Department; laboratory work under the supervision of Dr. Harold Brown, Environmental Protection Agency, Region VII, Kansas City, Missouri with assistance from Mr. Edward Glick, Division of Field Investigations, Cincinnati, Ohio. The overall study and report preparation was coordinated by Carl Walter, Environmental Protection Agency, Region VII.

INTRODUCTION

The problem of mercury contamination in the United States was first publicized in the spring and summer of 1970. An intensive program to define the hazard was undertaken by the combined Federal and State Governments. The emphasis of this program was to identify mercury users, assess their environmental impact, and to institute immediate control measures. At the same time, these locations where mercury contamination represented a real danger to the public could be quarantined.

The Governmental programs were comprised of industrial waste surveys of known mercury users and synoptic surveys of river systems receiving these wastes. The Black Hills of South Dakota have been a center of gold recovery operations for about a century. Initially an amalgamation separation process was used to extract gold from the ores obtained in placer mining throughout the Black Hills. About 1890, Homestake Mining Company began operations and until December 1970, there was a fairly regular discharge of mercury into the Black Hills streams.

Streams draining the eastern slope are tributary to the Cheyenne River, which flows into Lake Oahe. Samples of fish collected from the Cheyenne Arm of Lake Oahe in August and October 1970 showed that some species had concentrations of mercury over the 0.5 part per million (ppm) limit established by the Food and Drug Administration (Table 1).

The evidence of contaminated fish combined with the knowledge of mercury discharges provided the impetus for conducting this study. In April 1971, representatives of the Environmental Protection Agency,

TABLE 1

SUMMARY OF HISTORICAL DATA ON MERCURY IN FISH 1/

LAKE OAHE
SOUTH DAKOTA
MERUCRY CONCENTRATIONS IN FISH FLESH IN PPM

Just below Bismarck, North Dakota, 07-?-70

Northern Pike	0.34
Buffalo	0.23
Walleye	0.30

At U.S. 212 Bridge (Whitlock's Crossing), 05-21-70

Northern Pike	0.12
White Bass	0.08
White Crappie	0.10
Black Crappie	0.22
Perch	0.09
Sauger	0.13
Walleye	0.17

At U.S. 212 Bridge, 08-6-70

Northern Pike	0.10
Goldeye	0.16
Channel Catfish	0.11
White Bass	0.37
Black Crappie	0.40
Perch	0.14
Walleye	0.13

Cheyenne Arm, Foster Bay Area, 05-21-70

Northern Pike	0.27
Carp	0.16
Smallmouth Buffalo	0.14
Bigmouth Buffalo	0.33
Channel Catfish	0.14
White Bass	0.32
White Crappie	0.32
Black Crappie	0.35
Sauger	0.27
Walleye	0.20

Cheyenne Arm, Foster Bay Area, 08-6-70

Northern Pike (1 fish)	1.12
Goldeye	0.19
Channel Catfish	0.26
White Bass	0.84
Walleye	0.68

Cheyenne Arm, Foster Bay Area, 10-13-70

Northern Pike (Two 4-lb. fish)	1.16
Northern Pike (Two 1 1/2 lb. fish)	0.23
Carp	0.32
Channel Catfish	0.38
White Bass	0.54
Walleye	0.65

Cheyenne Arm, Minneconjou Bay Area, 10-14-70

Northern Pike (One 4-lb fish)	0.32
Goldeye	0.24
Carp (One 3-lb. fish)	0.38
Channel Catfish	0.18
White Bass	0.38
Walleye	0.38

1/ Data from South Dakota State Health Department compilation - Analyses by Food and Drug Administration.

Bureau of Sport Fisheries and Wildlife, and the State of South Dakota met to design a preliminary study that would further explore the incidence of mercury in fish in the Cheyenne Arm. The study plan required the Bureau of Sport Fisheries and Wildlife and State Department of Game Fish and Parks staff to collect the samples and Environmental Protection Agency staff to perform the analyses at the Bureau of Sport Fisheries and Wildlife laboratory in Pierre, South Dakota.

ANALYTICAL PROCEDURES

Sampling of the Fish Flesh

Gill and trap nets were placed at designated sampling points and fish were selected for flesh analyses on the basis of species. At the time of collection, the abdominal cavity of larger fish was slit open while smaller fish were left intact. All fish Specimens were frozen immediately on return to laboratory and were kept frozen until prepared for analyses. Figure 1 shows the sampling stations.

In preparation for analysis, a section of edible, skinless fish fillet weighing approximately five (5) grams was taken from each fish from the area near the dorsal fin. A five (5) gram composite of the eatable flesh was prepared including samples from all fish from a chosen species, location and size. An appropriately-sized aliquot of approximately equal weight was weighed out from each fish and these were combined to prepare the composite samples of near five (5) grams. The number of fish sampled for a given location and species type ranged from 1-6 fish, depending entirely upon the success of fishing at each collection site.

Fish Digestion

Vigorous chemical digestion was employed for all fish flesh. Samples were digested to insure that all forms of mercury in the flesh, including methyl and ethyl mercury and mercury complexed with larger organic straight - and branched - chain molecules,

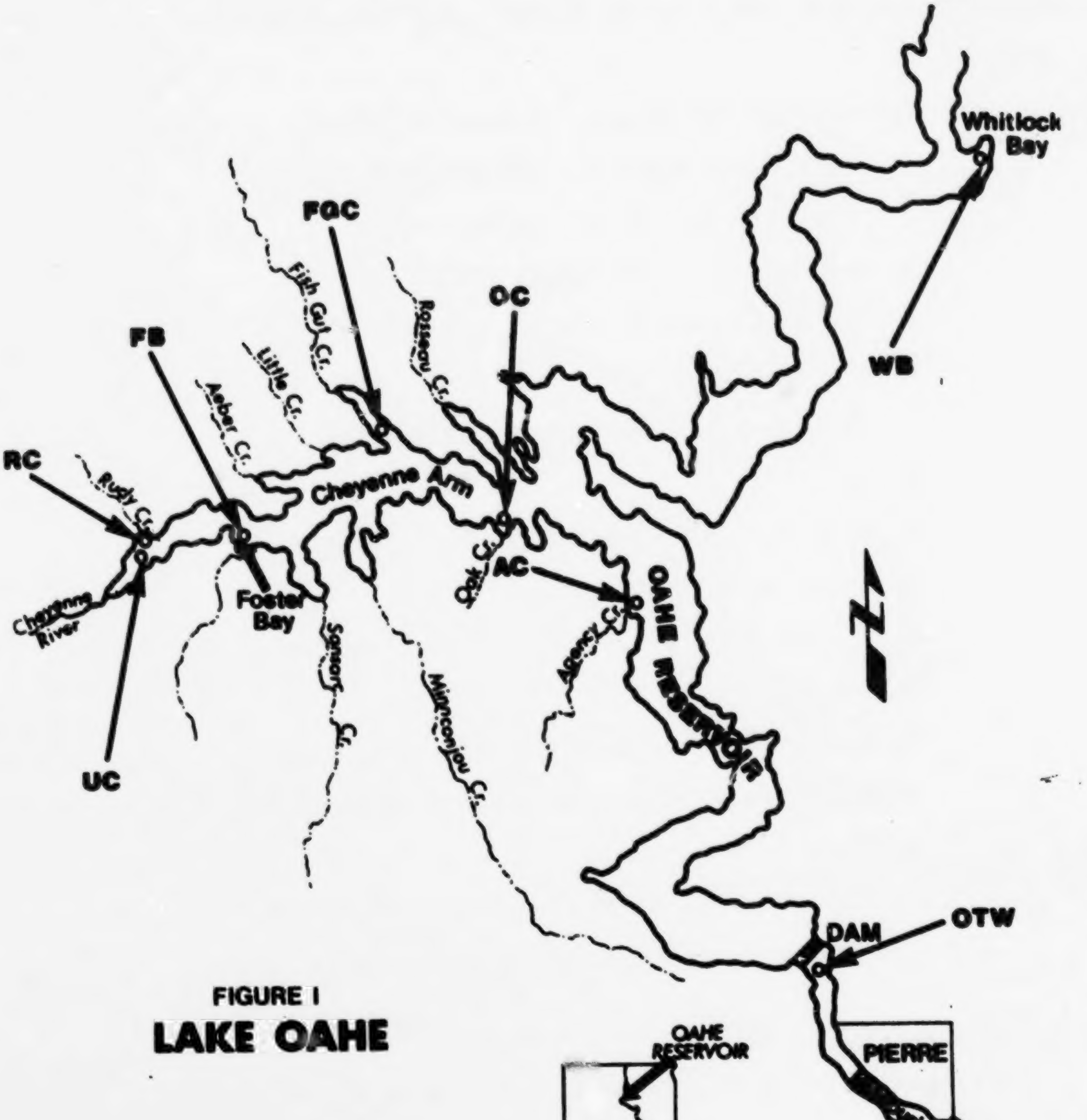


FIGURE I

LAKE OAHE

o – INDICATES LOCATION AND CODE FOR SAMPLING STATIONS FOR FISH AND APPROXIMATE LOCATION OF SEDIMENT TRANSECTS AND WATER SAMPLE COLLECTION SITES are converted into an inorganic form. The inorganic form of mercury is then reduced to the form of elemental mercury. The concentrations of total mercury in the fish flesh could then be determined by the Hatch and Ott [1/] flameless atomic absorption method.

The rigorous digestion technique used was as follows:

1. Place approximately five (5) grams of composited fish flesh in a 250 ml Erlenmeyer flask.
2. Add ten (10) mls of concentrated H_2SO_4.
3. Add ten (10) mls of concentrated HNO_3.
4. Continuously add sufficient $KMnO_4$ crystals in one (1.0) gram increments until the sample remains purple.
5. Place on a warm water bath (260° C) and allow to digest overnight (16 hours).
6. Add more $KMnO_4$ if necessary to retain the characteristic color.
7. Remove flask from the waterbath, cool to room temperature and dilute to 500 mls total volume with double distilled, deionized water.
8. Analyze treated and digested sample as with any water sample (procedure to be discussed later).

Sediment Sampling and Digestion

Sediment samples were collected on transects at the same localities in which the fish were collected from shore to shore. An orange peel dredge was used to obtain the sediments which

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[1/] Hatch, W.R., and Ott, W.L., "Determination of Sub-Microgram Quantities of Mercury by Atomic Absorption Spectrophotometry", Anal. Chem. 40, 2085 (1968).

were placed in plastic bags and frozen.

An aliquot of sediment weighing approximately 25 grams was taken from the larger sediment sample which weighed up to two (2) kilograms. The 25 gram aliquot was thoroughly and repeatedly mixed and an aliquot of approximately five (5) grams was sampled, weighed and placed into a 250 ml Erlenmeyer flask. The sample was rigorously digested by the same procedure as used with the fish flesh digestions. The samples were diluted to 500 mls total volume with double distilled, deionized water and stored in a polyethylene container.

Instrumentation

A Model MAS-50, Perkin-Elmer (Coleman) Mercury Analyzer [1] coupled with a strip-chart recorder with fast response time was used for all mercury determinations. An aeration device and pump are a part of the mercury analyzer. The absorption cell was constructed of borosilicate glass tubing (2.6 cm O.D.) with quartz windows (16 mm thickness) cemented to the ends. The Coleman mercury analyzer is equipped with a monochromatic light source of 253.7 nm wavelength and utilizes a flameless atomic absorption spectrophotometric method.

Brief Summary of Hatch and Ott Flameless Atomic Absorption Method for Mercury

The flameless atomic absorption technique for mercury is a physical procedure based upon the proportional absorption of monochromatic radiation at 253.7 nm wavelength by vaporized elemental mercury. The inorganic mercury in the aqueous samples

[1] Specific mention of brand names or model number does not constitute endorsement of equipment.

is reduced to the elemental state and aerated from the solution. The system is completely closed. The mercury vapor passes through a cell positioned in the light path of the Mercury Analyzer, a form of simple atomic absorption spectrophotometer. Absorbance (peak height) is measured as a function of the total mercury concentration.

Analytical Procedures for Mercury Analysis

A standard analytical procedure was utilized for the determination of the mercury concentrations in aliquots of the water samples, digested fish flesh samples and digested sediment samples.

The standard Hatch and Ott procedure for the analysis of mercury in aqueous samples is outlined below:

1. Transfer a 100 ml sample aliquot into a 300 ml BOD bottle.
2. Add five (5) mls of concentrated H_2SO_4.
3. Add ten (10) mls of 7N HNO_3.
4. Add five (5) mls of 5% $KMnO_4$ solution. Shake and add additional portions of potassium permanganate solution until the purple color persists for at least 15 minutes.
5. Add a 12% NaCl - 12% hydroxylamine sulfate solution in two (2) ml increments to reduce the excess permanganate.
6. Add ten (10) mls of 10% stannous sulfate in 0.5N H_2SO_4 and immediately attach the BOD bottle to the aeration apparatus.

7. Record mercury level as indicated by the reading on the Mercury Analyzer.

Precision and Accuracy of Test Results

Duplicate analyses were run on 22 of the 222 digested fish flesh composite samples. The average recovery on these duplicate mercury analyses was 102% assuming the first value to be the correct concentration. All 22 of these values fell within the range which is considered to be a resonable, acceptable working range, 100 ± 15%.

Standard spiked additions to the digested fish flesh samples were run on 52 of the fish composites which showed higher total mercury concentrations. The average recovery of these 52 spiked digested fish flesh samples was 97%. Four of these recovery values (81%, 68%, 124%, 116%) fell outside of the accepted 100 ± 15% range. The average recovery of the remaining 48 samples falling within the accepted range was 97%.

Standard "spiked" addition tests were made on 9 of the 43 sediment samples. The average mercury recovery for these spiked additions was 98%. One of the recovery values (80%) fell outside of the accepted 100 ± 15 % range. The average recovery of the remaining 8 spiked sediment samples was 101%.

Standard spiked additions to water samples were run on 10 of the 30 water samples. The average recovery of the spiked water samples was 99%. Three of these recovery values (70%, 120%, 120%) fell outside of the 100 ± 15% range. The average recovery of the remaining 7 spiked samples was 98%. Undoubtedly the low concentrations worked within these samples contributed to the number of samples which fell outside of the accepted range.

The Analytical Quality Control information is summarized in Table 2.

TABLE 2

ANALYTICAL QUALITY CONTROL

SAMPLE SOURCE	NUMBER OF DETERMINATIONS	AVERAGE PERCENTAGE RECOVERY OF MERCURY 1/
Duplicates of fish flesh analyses	22	102%
Spiked fish flesh analyses	52	97%
Spiked sediment analyses	9	98%
Spiked reservoir water analyses	10	99%

1/ Percentage of recovery on duplicate samples computed on the basis of the first value represents the 100% level and the duplicate or second value is the recovery percentage. Percentage recovery on spiked samples represents amount recovered based on value of the sum of first analysis and the spike.

ANALYTICAL RESULTS

Fish Flesh

The laboratory results of the fish flesh analyses are presented in Table 3. A total of 222 composite fish flesh samples comprised of 802 individual fish representing 22 species were analyzed. Positive mercury results were obtained from all composite samples and 30 of these or 15%, exceeded the 0.5 ppm limit tentatively established by the Food and Drug Administration. In addition, 14% of the composites ranges between 0.35 and 0.49 ppm of mercury in the edible flesh showing a total of 29% near or above the Food and Drug Administration tentative criteria. Even more significant is the distribution of species with the high mercury concentrations in the edible flesh. The northern pike which is a highly desirable game or sports fish had a greater percentage, 47% of composite samples, with mercury concentrations above 0.50 ppm in flesh. Most of these were fish from the Cheyenne Arm of Oahe. In addition to the northern pike, the walleye, which is a favorite sports food fish, had over 20% of the composite samples with concentrations of mercury in excess of the 0.5 ppm tentative safe limit.

Other species that also had high concentrations data of mercury in the edible flesh were fresh water drum, sauger, white bass, white crappie and channel catfish. These species represent the more desirable food fish and sports fish.

Table 4 presents data on the ranges of size and year class of fish in the composite samples. Comparison of the age information with the concentration data shows no clear cut relation between age and concentration.

TABLE 3

LAKE OAHE

FISH FLESH SAMPLES - MERCURY CONCENTRATIONS IN PPM AND NUMBER OF FISH IN COMPOSITE

STATION	DATE	N PIKE	WALL-EYE	W BASS	C CAT	FW DRUM	Y PERCH	SAUGER	WHITE CRAPPIE	BLACK CRAPPIE	BLACK BULLHEAD	CARP	RIVER CARPSUCKER
UC	10-07-70	0.38 (5)	0.54 (6)	0.39 (6)	0.73 (2)	0.60 (2)	----	----	----	0.24 (3)	----	0.35 (6)	0.23 (6)
UC	4-27-71	0.81 (6)	0.42 (6)	0.43 (6)	0.29 (6)	0.47 (6)	----	----	----	----	----	0.35 (6)	0.22 (6)
UC	5-11-71	1.05 (1)	0.56 (6)	0.74 (6)	0.26 (6)	0.39 (6)	----	0.57 (6)	----	----	----	0.43 (6)	0.21 (6)
FB	12-03-70	----	0.69 (2)	----	----	----	----	0.32 (1)	----	----	----	----	----
FB	4-23-71	0.42 (3)	0.67 (6)	0.50 (6)	0.34 (2)	0.64 (2)	0.24 (6)	----	0.42 (2)	0.66 (3)	0.23 (5)	----	----
FB	5-01-71	0.56 (4)	0.88 (4)	----	0.53 (4)	----	----	----	----	----	0.14 (5)	----	----
FB	5-19-71	0.61 (2)	0.12 (6)	0.40 (5)	0.21 (6)	0.35 (3)	0.08 (1)	0.32 (1)	----	----	0.08 (3)	0.20 (6)	0.11 (5)
FB	6-04-71	0.23 (1)	0.18 (6)	0.04 (1)	0.13 (2)	----	0.04 (1)	0.32 (1)	----	----	0.36 (1)	0.21 (1)	0.14 (4)
RC	11-24-70	----	0.37 (2)	----	----	----	----	0.55 (2)	----	----	----	----	----
FGC	4-29-71	0.24 (6)	0.16 (6)	0.27 (2)	0.28 (3)	0.51 (1)	0.21 (2)	----	----	----	----	0.27 (6)	0.13 (3)
FGC	5-13-71	0.51 (6)	0.12 (6)	0.23 (4)	0.17 (6)	0.43 (3)	----	0.15 (2)	0.48 (2)	0.60 (2)	----	0.10 (6)	0.08 (4)
OC	4-30-71	0.11 (3)	0.30 (6)	----	0.36 (5)	----	0.15 (1)	0.22 (3)	----	----	----	0.24 (6)	0.21 (1)
OC	5-14-71	0.76 (2)	0.27 (6)	----	0.27 (6)	0.50 (1)	----	0.32 (4)	----	----	----	0.16 (3)	0.16 (4)
AC	5-21-71	0.13 (1)	0.21 (6)	0.43 (1)	0.15 (6)	0.30 (1)	----	0.47 (3)	0.42 (1)	----	----	0.66 (6)	0.58 (2)
AC	6-04-71	0.30 (1)	0.10 (6)	0.12 (1)	0.42 (6)	----	----	----	----	0.31 (1)	----	0.23 (6)	0.10 (5)
WB	4-22-71	----	0.11 (2)	0.38 (1)	0.48 (2)	----	0.67 (1)	0.22 (1)	----	----	----	0.19 (3)	0.16 (2)
WB	5-18-71	0.55 (2)	0.17 (6)	----	0.19 (5)	----	0.15 (2)	0.26 (3)	----	----	----	0.29 (6)	0.24 (2)
WB	5-25-71	0.20 (2)	0.13 (1)	0.28 (1)	0.20 (6)	----	----	----	----	----	----	0.20 (1)	----
WB	6-02-71	0.52 (1)	0.16 (6)	----	0.22 (6)	0.40 (1)	0.14 (2)	0.13 (3)	0.14 (3)	----	----	0.17 (6)	0.14 (2)
OTW	12-01-70	0.20 (2)	0.10 (6)	0.02 (1)	----	----	0.04 (1)	0.17 (6)	----	----	----	----	0.20 (6)
OTW	4-23-71	----	0.16 (6)	----	0.29 (6)	----	----	0.13 (4)	----	----	----	0.16 (6)	0.15 (6)
OTW	5-19-71	----	0.10 (6)	----	0.13 (6)	----	----	0.13 (1)	----	----	0.17 (6)	0.11 (1)	0.14 (6)
POLLOCK	4-06-71	0.25 (6)	----	----	----	----	----	----	----	----	----	----	----
GRAND RIVER	4-07-71	0.36 (6)	----	----	----	----	----	----	----	----	----	----	----
BLUE BLANKET CREEK	4-09-71	0.27 (6)	----	----	----	----	----	----	----	----	----	----	----

TABLE 3 Cont'd.

LAKE OAHE

FISH FLESH SAMPLES - MERCURY CONCENTRATIONS IN PPM AND NUMBER OF FISH IN COMPOSITE

STATION	DATE	GOLD-EYE	BM BUFFALO	SM BUFFALO	SHORTHEAD REDHORSE	SN STURGEON	BLUE SUCKER	WHITE SUCKER	BURBOT	SN GAR	STONE CAT
UC	10-07-70	0.22 (6)	----	----	----	----	----	----	----	----	----
UC	4-27-71	0.29 (6)	0.34 (5)	----	0.20 (1)	----	----	----	----	----	----
UC	5-11-71	0.31 (6)	0.48 (6)	0.24 (1)	0.11 (1)	----	----	----	----	----	----
FB	12-03-70	----	----	----	----	----	----	----	----	----	----
FB	4-23-71	0.20 (2)	----	----	----	----	----	----	0.24 (3)	----	----
FB	5-01-71	----	----	----	----	----	----	----	----	----	----
FB	5-19-71	0.18 (6)	0.34 (2)	0.10 (6)	0.06 (2)	----	----	----	----	----	----
FB	6-04-71	0.43 (6)	----	----	0.23 (6)	----	----	----	----	----	----
RC	11-24-70	0.23 (4)	----	----	----	----	----	----	----	----	----
FGC	4-29-71	0.18 (2)	----	----	0.09 (1)	----	----	----	----	----	----
FGC	5-13-71	0.02 (1)	0.31 (5)	0.10 (4)	0.02 (3)	0.21 (3)	----	0.16 (1)	0.16 (1)	----	----
OC	4-30-71	0.24 (7)	----	0.14 (1)	0.07 (2)	----	----	----	----	----	----
OC	5-14-71	0.19 (1)	0.33 (3)	0.27 (2)	0.08 (4)	0.18 (3)	----	----	----	----	----
AC	5-21-71	0.27 (6)	0.40 (2)	----	0.09 (1)	0.59 (5)	----	----	----	----	----
AC	6-04-71	0.09 (6)	0.22 (3)	----	0.09 (1)	0.15 (5)	----	----	----	0.34 (2)	----
WB	4-22-71	0.19 (1)	0.61 (3)	----	0.11 (1)	0.18 (4)	----	----	----	----	----
WB	5-18-71	0.18 (6)	0.45 (1)	----	0.10 (6)	0.30 (1)	----	0.07 (2)	0.30 (1)	----	----
WB	5-25-71	----	----	----	----	0.20 (6)	----	----	----	----	----
WB	6-02-71	0.17 (6)	----	----	0.09 (5)	----	----	0.19 (1)	----	0.44 (6)	0.15 (1)
OTW	12-01-70	0.13 (5)	----	----	----	----	----	----	0.24 (3)	----	----
OTW	4-23-71	0.18 (6)	0.24 (6)	----	0.19 (3)	----	----	0.08 (1)	----	----	----
OTW	5-19-71	0.13 (1)	0.14 (3)	0.14 (5)	0.05 (6)	----	0.18 (4)	----	----	----	----
POLLOCK	4-06-71	----	----	----	----	----	----	----	----	----	----
GRAND RIVER	4-07-71	----	----	----	----	----	----	----	----	----	----
BLUE BLANKET CREEK	4-09-71	----	----	----	----	----	----	----	----	----	----

TABLE 4

MERCURY INVESTIGATION - LAKE OAHE

LENGTH - AGE DATA FOR FISH SPECIES IN COMPOSITE SAMPLES

RANGES OF LENGTH[1/] - RANGES OF AGE[2/]

Collection Number	Station Number	Date	Northern Pike	Walleye	White Bass	Channel Catfish	Freshwater Drum	Yellow Perch	Sauger	White Crappie	Black Crappie
652	UC	4/27/71	55-75 II-VI	34-55 IV-VIII	26-29 IV-V	28-52 VI-XI	30-41 IV-V				
658	UC	5/11/71	62 V	23-69 II-IX	21-36 III-VI	18-41 III-X	23-43 IV-V		35-50 III-IV		
663	FB	5/19/71	83-94 VI-VIII	27-58 III-VIII	28-31 IV-VI	24-50 VI-XI	35-43 V-VI	17 III	33 V		
667	FB	6/03/71	51 III	25-56 II-IX	13 I	28-36 IX-X		16 III	35 VI		
653	FGC	4/29/71	49-68 II-VI	24-49 II-VI	22-28 II-V	31-40 VIII-X	38 VI	14-16 II-III			
659	FGC	5/13/71	46-90 II-VI	18-47 II-VII	28-37 IV-V	28-35 VIII-X	38-57 V-X		28-32 IV-VI	29-30 V	28-30 VI-VII
654	OC	4/30/71	43-56 II	20-47 II-VI		29-39 IX-X		19 IV	31-33 III-IV		
660	OC	5/14/71	72-80 VIII	30-46 IV-VI		28-38 VIII-X	32 V		28-33 II-IV		
648	WB	4/22/71		28-34 II-III	31 V	36-48 X		24 VI	37 V		
66C	WB	5/18/71	65-67 VI	23-45 II-VI		30-38 VII-IX		18-19 IV	30-34 III-VI		
664	WB	5/25/71	48-49 II	31 III	28 V	25-68 VI-XVI					
666	WB	6/02/71	68 VI	24-52 II-VII		30-43 VII-XII	39 VII	13-23 II-V	28-35 II-III	16-27 II-V	
631	OTW	12/1/70	17-56 0-VII	10-12 0				14 II	26-36 I-II		
649	OTW	4/23/71		22-47 II-VI		33-52 IX-XIV			25-35 II-III		
662	OTW	5/19/71		17-54 I-VI		19-47 VII-XIV			40 V		
637	Pollock	4/06/71	44-72 II-VI								
639	Grand R.	4/07/71	52-90 II-VIII								
640	Blue Blanket Cr.	4/09/71	44-90 II-VI								

* Aging Techniques Have Not Been Validated for These Species.

1/ Fork Length in Centimeters

2/ Age Scale Based on Calendar Year. 0 Indicates Young of the Year, I Indicates First Calendar Year After Hatching, Etc.

TABLE 4 (Page 2)

MERCURY INVESTIGATION - LAKE OAHE
LENGTH - AGE DATA FOR FISH SPECIES IN COMPOSITE SAMPLES
RANGES OF LENGTH[1/] RANGES OF AGE[2/]

Collection Number	Station Number	Date	Black Bullhead	Carp	River Carpsucker	Goldeye	Bigmouth Buffalo	Smallmouth Buffalo	Shorthead Redhorse	Shovelnose Sturgeon	Blue Sucker	White Sucker	Burbot
652	UC	4/27/71		36-54 VI-IX	21-48 II-XIII	30-36 IV-VI	47-59 VIII-XI		34 III				
658	UC	5/11/71	24 IV	33-50 VI-IX	32-48 VII-XII	16-35 I-VI	48-58 VIII-XI	49 VIII	33 IV				
663	FB	5/19/71	18-22 IV-VIII	37-49 VII-IX	33-44 IV-XI	29-37 IV-VI	49-51 IX	44-53 VIII-X	34-37 IV				
667	FB	6/03/71	23 X	46 VIII	33-48 IV-XI	30-38 IV-V			28-41 III-IX				
653	FGC	4/29/71		39-50 VIII-X	35-45 V-X	30 V			36 V				
659	FGC	5/13/71		38-43 VII-IX	41-48 VII-XI	22 II	50-56 VIII-X	46-54 VII	34 IV	51-53 *		41 V	62 *
654	OC	4/30/71		37-44 VII-VIII	44 XI	25-35 III-VI		46 VI	34-36 III-V				
660	OC	5/14/71		39-47 VI-VII	41-46 VI-VIII	32 III	53-54 VII-VIII	44-47 VII-VIII	33-38 III-IV	52-55 *			
648	WB	4/22/71		37-58 V-IX	42-44 VIII-X	23 II	48-58 VI-VIII		32 IV	53-69 *			
66C	WB	5/18/71		37-42 VI-VIII	40-44 VIII	23-36 II-VI	55 IX		31-36 III-IV	59 *		17-35 II-IV	64 *
664	WB	5/25/71		46 VII		23 II				52-65 *			
666	WB	6/02/71		36-51 V-VIII	40-42 VIII-IX	30-34 IV-V			30-35 IV			39 VI	
631	OTW	12/1/70			36-48 VI-IX	23-24 I-VI							73-75 *
649	OTW	4/23/71		29-32 III-V	26-49 IV-XIII	30-36 V-VII	42-57 V-IX		24-36 III-V			34 III	
662	OTW	5/19/71	17-28 IV-VII	33 IV	32-50 IV-XII	30 IV	48-51 VII	36-51 VII-IX	27-42 IV-VII		52-58 VII		

* Aging Techniques Have Not Been Validated for These Species.

1/ Fork Length in Centimeters

2/ Age Scale Based on Calendar Year. 0 Indicates Young of the Year, I Indicates First Calendar Year After Hatching, Etc.

However, several of the samples showing the highest concentrations of mercury also were comprised of older and larger fish.

The overall body of data demonstrates the occurance of high mercury concentrations in the edible skinless flesh of most of the game fishes in the Cheyenne Arm of Lake Oahe. The highest mercury concentrations were found in northern pike and walleye near the headwaters of the Cheyenne Arm.

Comparative data from remote locations in Lake Oahe and in Lake Sharp demonstrated lower mercury levels in fish than those observed in the Cheyenne Arm.

Fresh flesh concentrations in Lake Sharp did not exceed 0.29 ppm and composites from the remote stations of Pollock, Grand River and Blue Blanket Creek had a maximum of 0.36 ppm (Table 3).

One anomaly in the data is the four samples of fish, northern pike, yellow perch and bigmouth buffalo from Whitlock Bay which had mercury concentrations in excess of 0.5 ppm.

Sediment

Sediments were collected from transects at five locations providing a total of 43 separate samples. Laboratory analysis of these sediments demonstrated mercury in the bottom deposits of the Cheyenne Arm of Lake Oahe and at Whitlock Bay. These data are presented in Table 5. The evident trends are the higher concentrations in the center of the channel and the decreasing concentrations in the downstream direction. This trend is to be expected since the settleable material tends to move to the deeper areas through sloughing or turbulent resuspension and settling.

The mercury concentrations observed in mid-channel of the upper reaches demonstrate the contributions of the Cheyenne River. The higher concentrations shown in dredged samples are not indicative of the total quantity that might be present. However, these data do provide an indication of the source of mercury in fish. Elemental mercury in sediment is of great concern due to the potential of methylation which converts the mercury to a more toxic form. Methylation may occur in either aerobic or anaerobic conditions by a wide variety of organisms and it is the methylmercury form that is generally found in animal tissue. Methylmercury is also the best absorbed and the most slowly lost from animal tissue.

The chain of transmission of mercury to methylmercury to animal tissue is not understood completely. The traditional food-chain relation is not always evident and the capability of accumulation in tissue from repeated minute intakes adds complexity.1/ In the case of Lake Oahe the methylation process and chain of transmission should be investigated fully.

Water

Water samples were collected from ten separate locations in the Lake. The vertical water column was sampled near the surface and bottom and at mid-depth with a Van Dohrn Sampler. The results of the laboratory analyses are shown in Table 6. The concentrations are reported as less than 0.2 micrograms per liter which is the lower detection limit.

1/ Selikoff, Irving J., ed., "Hazards of Mercury" a special report to the Secretarie's Pesticide Advisory Committee, Dept. of Health, Education and Welfare, November 1970. Environmental Research 4, 1. (1971)

TABLE 5

SEDIMENT SAMPLES

MERCURY CONCENTRATIONS IN PPM AND WET AND DRY WEIGHTS 1/

STATION	DATE	SOUTH SHORE	200 YDS FROM SOUTH SHORE	300 YDS FROM SOUTH SHORE	400 YDS FROM SOUTH SHORE	MIDDLE	400 YDS FROM NORTH SHORE	200 YDS FROM NORTH SHORE	NORTH SHORE
UC	4-27-71	0.07 0.10	----	0.28 0.49	----	0.30 0.48	----	0.32 0.53	0.06 0.08
UC	5-10-71	0.06 0.08	0.24 0.39	----	----	0.24 0.39	----	0.18 0.31	0.04 0.06
FGC	4-29-71	0.06 0.08	----	----	0.24 0.41	0.20 0.35	0.33 0.62	----	0.04 0.05
FGC	5-12-71	0.03 0.04	----	----	0.07 0.11	0.06 0.11	0.07 0.12	----	0.05 0.08
OC	5-14-71	<0.03 <0.04	----	----	----	0.07 0.12	0.26 0.50	----	0.05 0.07
OC	5-13-71	0.04 0.05	----	----	0.08 0.13	0.10 0.17	----	----	0.12 0.16
AC	5-20-71	<0.03 <0.03	----	----	<0.03 <0.04	0.03 0.06	0.16 0.30	----	0.03 0.04
AC	6-04-71	<0.03 <0.03	----	----	<0.03 <0.03	<0.03 <0.03	<0.03 <0.03	----	0.03 0.04
WB	6-07-71	0.06 0.09	----	----	0.03 0.08	<0.03 <0.04	<0.03 <0.04	----	0.03 0.04

1/ Upper value is wet concentration and lower value is dry concentration.

TABLE 6

WATER SAMPLES

MERCURY CONCENTRATIONS IN PPB

STATION	DATE	SHALLOW WATER			DEEP WATER		
		1 YD. FROM SURFACE	MIDDEPTH	1 YD. FROM BOTTOM	1 YD. FROM SURFACE	MID-DEPTH	1 YD. FROM BOTTOM
FB	6-09-71	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
FGC	6-11-71	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
OC	6-11-71	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
AC	6-03-71	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2
WB	6-07-71	<0.2	<0.2	<0.2	<0.2	<0.2	<0.2

SUMMARY AND RECOMMENDATIONS

A cooperative Federal - State survey of occurrence of mercury in the fish, sediment and water in Lake Oahe with emphasis on the Cheyenne Arm was conducted in the summer of 1971. Mercury analyses were performed on 295 separate samples comprised of 222 composite fish samples, 43 sediment, and 30 water samples. The results of these analyses show positive occurrence of mercury in concentrations near or above the recommended Food and Drug Administration limit of 0.5 ppm in 29% of the fish samples with the preponderance of high levels in the more desirable game fish.

The data show the highest mercury concentration occurred in northern pike and walleye samples from collections in the upper Cheyenne Arm. Analyses of grab sediment samples show the higher concentrations in the Cheyenne Arm head waters area. The result of the water analyses indicate a mercury level below detectable concentrations at all stations sampled.

Based on the above information it is recommended that:

1. A continuing surveillance program be developed to monitor the mercury concentrations in the fish in Lake.

2. Public warning signs be posted in prominent areas to warn fishermen of potential hazards of consuming fish harvested from the Cheyenne Arm of the Lake.

3. An investigation be made to determine the scope and amount of mercury in the sediments and the amount of mercury in the sediments and the amount of mercury in the fish, including the chain of transmission.

Dr. T. J. Hassler

DR. HASSLER: The problem of mercury contamination in the United States was first publicized in the spring and the summer of 1970. An intensive program to define the hazard was undertaken by the combined Federal and State governments.

The governmental programs were comprised of industrial waste surveys of known mercury users and synoptic surveys of river systems receiving these wastes. The Black Hills of South Dakota have been a center of gold recovery operations for about a century. Initially an amalgamation separation process was used to extract gold from the ores obtained in placer mining throughout the Black Hills. About 1890 Homestake Mining Company began operations and until December 1970 there was a fairly regular discharge of mercury into the Black Hills streams.

Streams draining the eastern slope are tributary to the Cheyenne River, which flows into Lake Oahe. Samples of fish collected from the Cheyenne Arm of Lake Oahe in August and October 1970 showed that some species had concentrations of mercury over the 0.5 ppm limit established by the Food and Drug Administration.

The evidence of contaminated fish combined with the knowledge of mercury discharges provided the impetus for conducting this study. In April 1971 representatives of the Environmental Protection Agency, Bureau of Sport Fisheries &

Wildlife, and the State of South Dakota met to design a preliminary study that would further explore the incidence of mercury in fish in the Cheyenne Arm. The study plan required the Bureau of Sport Fisheries & Wildlife and State Department of Game, Fish and Parks staff to collect samples and the Environmental Protection Agency staff to perform the analyses at the Bureau of Sport Fisheries & Wildlife laboratory in Pierre, South Dakota.

Fish, water and bottom sediments were sampled. For fish sampling, gill and trap nets were placed at designated sampling points. At Cheyenne embayment, Agency Creek, which is some 6 miles below the confluence of the Cheyenne and Missouri Rivers, Whitlock Bay, which is some 25 river miles above the confluence of the Cheyenne and Missouri, and Lake Sharpe, immediately below Oahe Dam.

Fish were selected for flesh analyses on the basis of species. All fish specimens were frozen immediately on return to the laboratory and kept frozen until prepared for analysis.

In preparation for analysis, a section of edible, skinless fish fillet weighing approximately 5 grams was taken from each fish from the area near the dorsal fin. Samples of from one to six fish were combined to prepare a composite sample. The number and species of fish making up the composite sample depended upon the success of fishing at each collection site.

A chemical digestion was employed for all fish flesh. Samples were digested to insure that all forms of mercury in the flesh were converted into an inorganic form.

Sediment samples were collected on transects from shore to shore at the same locations in which fish were collected. Sediments were packaged and frozen.

An aliquot of sediment was digested by the same procedure used for the fish flesh digestion.

Water samples were collected at sampling locations 1 meter from the surface and bottom and at mid depth. Samples were analyzed upon return to the laboratory.

The digested flesh and sediment samples and water were analyzed using the standard Hatch and Ott procedure for the analysis of mercury in aqueous samples. A Perkin-Elmer mercury analyzer coupled with a strip chart recorder was used for all mercury determinations.

Duplicate analyses were run on 22 of the 222 fish flesh composite samples and standard spiked additions on 52 of the fish composites which showed higher total mercury concentration.

In addition, standard spiked additions were run on 9 of the 43 sediment samples and 10 of the 30 water samples.

A total of 222 composite fish flesh samples, comprised of 802 individual fish representing some 22 species, were analyzed. Positive mercury results were obtained from all composite samples and 30 of these, or 15 percent, exceeded the 0.5 ppm limit tentatively established by the Food and Drug Administration. In addition, 14 percent of the composites ranged between 0.35 and 0.49 ppm of mercury in the edible flesh, showing a total of 29 percent near or above the Food and Drug Administration tentative criteria. Even more significant is the distribution of species with high mercury concentrations in the edible flesh. The northern pike, which is a highly desirable game fish, had a greater percentage, 47 percent of composite samples, with mercury concentrations above the 0.5 ppm recommended level in flesh. Most of these were fish from the Cheyenne Arm of Lake Oahe. In addition to the northern pike, the walleye, which is a favorite sports food fish, had over 20 percent of the composite samples with concentrations of mercury in excess of 0.5 ppm tentative safe limit.

Other species that also had high concentrations of mercury in the edible flesh were freshwater drum, sauger, white bass, white crappie and channel catfish. These species represent the more desirable food and sport fishes in Lake Oahe.

Comparison of the age data information with the concentration data shows no clear-cut relationship between age and concentration. However, several of the samples showing the highest concentrations of mercury also were comprised of older and larger fish.

The overall body of data demonstrates the occurrence of high mercury concentrations in the edible skinless flesh of most of the game fishes in the Cheyenne Arm of Lake Oahe. The highest mercury concentrations were found in northern pike and walleye near the headwaters of the Cheyenne Arm.

Comparative data from remote locations in Lake Oahe and in Lake Sharpe, which is immediately below Lake Oahe, demonstrated lower mercury levels in fish than those observed in the Cheyenne Arm.

Mercury concentrations in Lake Sharpe fish did not exceed 0.29 ppm and composites from the remote stations of Pollock, Grand River and Blue Blanket Creek, Lake Oahe, had a maximum of 0.36 ppm in the edible flesh.

One anomaly in the data is the four samples of fish, northern pike, yellow perch and bigmouth buffalo from Whitlock Bay which had mercury concentrations in excess of the

0.5 ppm limit.

Sediments were collected from transects at five locations providing a total of 43 separate samples. Laboratory analysis of these sediments demonstrated mercury in the bottom deposits of the Cheyenne Arm and Lake Oahe.

The evident trends within the Cheyenne Arm are the higher concentrations in the center of the channel and decreasing concentrations in the downstream direction, and concentrations were considerably higher in the Cheyenne Arm than at Whitlocks Crossing above the Cheyenne or Agency Creek, which is below the Cheyenne.

The mercury concentrations observed in midchannel of the upper reaches of the Cheyenne Arm demonstrate the contributions by the Cheyenne River. The higher concentrations shown in dredge samples are not indicative of the total quantity that might be present. However, these data do provide an indication of the source of mercury in fish. Elemental mercury in sediment is of great concern due to the potential of methylation which converts the mercury to a toxic form. Methylation may occur in either aerobic or anaerobic conditions by a wide variety of organisms and it is the methyl form that is generally found in animal tissue. Methylmercury is also the best absorbed and the most slowly lost from animal tissue.

Dr. T. J. Hassler

The chain of transmission of mercury to methylmercury to animal tissue is not understood completely. The traditional food chain relation is not always evident and the capability of accumulation in tissue from repeated minute uptakes adds complexity. In the case of Lake Oahe, the methylation process and chain of transmission should be investigated fully.

Water samples collected from the vertical water column had mercury concentrations of less than 0.2 µg/l, which is the lower detection limit.

Now, in summary of this Federal-State survey, occurrence of mercury in the fish was demonstrated from the Lake Oahe area. Mercury analyses were performed on 295 separate samples comprised of 222 composite fish samples, 43 sediment samples, and 30 water samples. The results of these analyses show positive occurrence of mercury in concentrations near or above the recommended Food and Drug Administration limit of 0.5 ppm in 29 percent of the fish samples with the preponderance of high levels in the more desirable game fish.

The data show the highest mercury concentration occurred in northern pike and walleye samples from collections in the upper Cheyenne Arm. Analyses of sediment samples show the higher concentrations in the Cheyenne Arm near the headwaters area. The results of the water analyses indicate a mercury level below detectable concentrations at all stations sampled.

Based on the above information it is recommended that:

1. A continuing surveillance program be developed to monitor the mercury concentrations in the fish in Lake Oahe.

2. Public warning signs be posted in prominent areas to warn fishermen of potential hazards of consuming fish harvested from the Cheyenne Arm of Lake Oahe.

3. An investigation be made to determine the scope and amount of mercury in the sediments and the amount of mercury in the fish, including the chain of transmission.

MR. STEIN: Thank you.

Are there any comments or questions?

Yes.

MR. GRIMES: Mr. Chairman.

I assume that the recommendation here that additional investigation should be made as to the food chain will bring forth the reason why the northern pike and the walleye, which are a fish-eating fish, accumulate this greater concentration in their tissue than the fish that they eat. I assume that.

MR. STEIN: Yes. Well, I think again--

Yes, do you have a comment?

DR. HASSLER: This is one of the problems at the present time. We don't understand how, when they are eating fish with a lower concentration, that they can accumulate it. And we would like to find this out, not only from the human health hazard from the effects of mercury but the effects of mercury on the reproduction and survival of the fishes, because we are concerned with the fish as well as the human aspect.

MR. GRIMES: I would like to speculate here a little bit. These northern and walleyes eat so darned many of those fish with lesser concentration that they build up the concentration in their own flesh.

MR. STEIN: Right.

MR. GRIMES: This is nothing more than leading to how many fish does it take to get a full concentration in the flesh, principally humans.

MR. STEIN: Sir, I think we have similar problems with perhaps oceangoing fish and fish indigenous to other areas. I am all for research and checking precisely the food chain, but I think the theory we have all come up with is about what you have said--that as you get an older or bigger fish and they eat smaller fish,they tend to concentrate more mercury within their own bodies.

In other areas of the country it has been decided certainly to let this research go on, but since we know this is occurring, the regulatory program is to be directed toward securing the most rapid abatement of the discharge of mercury into the waters, and I suspect there has been a tremendous effort made to check this chain that Dr. Hassler talked about. I hope we get an answer very rapidly, but I know a lot of people have been working on it. The question the conferees have to weigh is whether working toward that answer which we need should in any way delay the regulatory program to prevent the mercury from getting into the stream.

Are there any other comments or questions?

DR. HAYES: Mr. Chairman, I notice that Mr. Hassler's conclusion and summary covered three points, and I also notice in the recommendations in the black-covered book under Item 5, which dealt, I presume, with his report, that No. 3, as I see it, perhaps I am in error, leaves out Recommendation No. 3. I don't know whether it was intended or unintentional. But it would seem that certainly you have hit on a key point, that there does need to be continued investigation to determine the scope and amount of mercury in the sediments and the amount of mercury in the fish, including the chain of transmission. But I notice that Item 5 in the black book does not cover that recommendation.

I certainly feel that that should be included, and I don't know whose prerogative it is, but I would assume that we can request it be put in.

MR. DICKSTEIN: The conferees could put it in.

DR. HAYES: Fine. Let's take it up later, then.

MR. STEIN: That is right. I think we have several suggestions, one from Dr. Hassler and one from the black report. The black report says commercial fishing in the Cheyenne and Oahe Reservoir should be prohibited, and presumably that is by the State. Dr. Hassler's report comes up with a recommendation that this portion of the waters be posted that fishermen should not eat the fish caught from there.

I think these are suggestions for the conferees in view of what you would think would be the hazard of that. I think these are just recommendations. They are somewhat different, but they go to the same problem.

Are there any other questions or comments?

If not, thank you very much.

I wonder if we could recess for lunch now until a quarter to 2.

(NOON RECESS)

AFTERNOON SESSION

TUESDAY, OCTOBER 19, 1971

(1:45 o'clock)

MR. STEIN: Let's reconvene.

Mr. Dickstein.

MR. DICKSTEIN: At this time I would like to call on Dr. Sam I. Shibko, Assistant to the Director, Division of Toxicology, the Federal Food and Drug Administration, Washington, D. C.

Dr. Shibko.

DR. SAMUEL I. SHIBKO
ASSISTANT TO THE DIRECTOR
DIVISION OF TOXICOLOGY
FOOD AND DRUG ADMINSTRATION
WASHINGTON, D. C.

DR. SHIBKO: Mr. Chairman, Federal conferees, ladies and gentlemen.

My name is Sam Shibko. I work in the Division of Toxicology of the Food and Drug Administration, Washington, D. C. I am pleased to be here today to discuss the problems associated with mercury residues present in fish. My discussion will deal mainly with the possible toxicological effects associated with these residues.

Dr. S. I. Shibko

Mercury is discharged into the environment in one of the following forms: (A) as a metallic mercury, (B) the inorganic divalent ion, for example mercuric chloride, (C) this should read aryl not alkyl mercury as in the text here, for example, phenylmercuric acetate, (D) alkoxy alkyl mercury, for example methoxyethylmercury acetate, and (E) alkyl mercury, for example ethyl- and methylmercury. Each of these forms of mercury has or has had industrial or agricultural uses.

In addition to pollution due to man's activities, mercury may enter the biosphere through geological formations through the process of leaching or volatilization. However, all forms of mercury entering the aquatic environment, either as a result of man's activities or from natural geologic sources, may be converted to methylmercury, which can be concentrated by fish and other aquatic species. It has been clearly established that the form of mercury in edible fish muscle is almost completely methylmercury. Methylmercury is more toxic chronically than other forms of mercury. This will be discussed in some detail later.

The biological methylation of mercury was described by Woods in 1968. The reaction is enhanced by anaerobic conditions and by increasing numbers of bacteria capable of synthesizing alkylcobaltamines, which provides a natural substrate for the methylation reaction. A number of microorganisms can methylate mercury, but the major contributors have not been identified. Both monomethyl- and dimethylmercury are formed as products of this reaction. High mercurial concentrations favor the formation of the monomethyl form, and alkaline pH's favor the dimethyl form.

Dimethylmercury decomposes to the monomethyl form at acid pH. The importance of this process is that it is capable of mobilizing what otherwise might be stable deposits of mercury in sediments into the highly toxic and transportable methyl forms. The significance of such reactions in the contamination of aquatic species was first suggested at the time of the Minamata episode, but this relationship was not fully recognized at that time because it was established that methylmercury was actually present in the effluent from the plant, causing the contamination.

However, the delineation of this reaction and the subsequent work by Swedish scientists showing that methylation could occur with natural sediments, as well as the information from both the Swedish and American mercury pollution problems, indicates that the methylation of mercury in sediments on river and lake bottoms is the major contributor to the current contamination of aquatic species. It has not been established if methylation may occur by the action of microorganisms on the skin of fish, or in the GI tract of fish. Fish may concentrate methylmercury either directly through the water or through components of the food chain.

Studies by Finnish scientists (Miettinen) have shown that methylmercury is lost from fish at an extremely slow rate. The loss appears to occur in two stages: first a rapid loss when mercury is being distributed throughout the tissues, a process that lasts a few weeks, and then a very slow loss from the established binding sites. The half-life estimated from this component is approximately 2 years. This extremely slow loss is one of the reasons why fish are a major source of mercury for man. Further, during this period the fish are continuously supplied with methylmercury from the water, providing a mechanism for the continuous increase of mercury residues.

It has not been clearly established at what level methylmercury is toxic for aquatic organisms. At Minamata, dead fish and shellfish were reported to contain 9 to 24 ppm. Experimental studies by Miettinen have shown muscle levels average 6.4 to 7.4 ppm in pike experimentally killed with methylmercury. However, it is possible that stunted growth, behavioral effects and reproductive effects may occur at lower levels. It is likely that effects will not be observable at muscle levels of 1 to 2 ppm, so that visually we would not expect to distinguish contaminated fish from uncontaminated fish. As I have previously indicated, mercury residues in fish muscles are almost entirely in the form of methylmercury and that chronically this form of mercury is more toxic than any of the other forms.

The extremely hazardous nature of these residues in fish has been emphasized by the Minamata Bay and Niigata poisoning episodes. In the Minamata episode at least 121 cases have been reported. Of these, 68 were adults, 34 dead, 30 infantile, 10 dead, and 22 fetal, 3 dead. The clinical features in children and adults included paresthesias (numbness and tingling), progressive incoordination, loss of vision and hearing, and intellectual damage. The brain damage was apparent by the time of diagnosis and no effective therapy was possible. The number of cases affected in this outbreak may have been much greater than reported, because in the case of the Niigata episode, which involved 48 persons, 6 of which have died, many cases with relatively less neurological damage were diagnosed.

In the case of the fetal toxicity reported in Minimata all cases occurred in families that had been exposed to contaminated fish, but none of the mothers had been clinically diagnosed as poisoning cases. Because the fetus appears to be more sensitive than the mother, there is great concern that women of childbearing age should not be exposed to contaminated fish. Studies with other individuals, both in Japan and Sweden, show that methylmercury crosses the placental barrier and is at a higher concentration in the fetal red blood cells than maternal red blood cells, although fetal plasma concentrations of mercury are lower than those in the mother.

Detailed studies of the patients of these poisoning episodes, particularly information on mercury levels in blood, hair, and in some cases brain, has provided valuable information for estimating acceptable levels for exposure of man to methylmercury. Additional information has also been provided by: (a) studies in Scandanavia on the metabolism of trace amounts of Hg^{203} labeled methylmercury by man. These studies have enabled us to calculate the half-life on mercury in man, about 70 days, and also the relative concentration of mercury in the various parts of the body. And (b) the relationship between ingestion of methylmercury from contaminated fish and mercury levels in blood and hair. This information will be discussed in some detail in the evaluation of mercury residues in fish.

At present there are no sensitive diagnostic techniques to identify possible subclinical and latent mercury toxicity. Of particular concern in relation to possible undetected injury are reports that individuals who have been exposed to methylmercury, or alkyl mercurials, may continue to function in an apparent normal manner and then at death, some years later, show the complete pathologic brain lesions associated with the exposure. It is not known to what extent man's brain can compensate for neuronal loss that may occur following exposure or how neuronal loss following low levels of exposure affects the normal aging process of the brain. Until suitable techniques are developed to study these effects, the only means of protection is to keep exposure to mercury at the lowest possible level.

Another effect in humans who have been exposed to contaminated fish, and who do not show any of the typical symptoms of methylmercury poisoning, is the observed chromosomal aberrations noted in cultured lymphocytes from these individuals. The significance of this effect is unknown, but points to the possible mutagenic effect of the methylmercury.

For the purpose of toxicological considerations it is usual to consider three classes of mercury, namely: (1) inorganic mercury, along with phenylmercury and alkoxy mercury--the latter two are rapidly metabolized and show similar toxicological patterns to inorganic mercury--(2) mercury vapor, and (3) alkyl mercurials.of which methylmercury is a typical example. In the case of the first group, these substances are particularly known for their effects on liver and kidney, whereas alkyl mercurials are known mainly for their effects on the central nervous system.

Only alkyl mercurials and mercury vapor are known to give symptoms and signs of disturbances of the central nervous system. In addition, alkyl mercurials are known to be able to cross the placental barrier and enter the fetus, whereas the placenta may be an efficient barrier to other forms of mercury.

Factors which appear to account for these important differences on the toxicology of mercurials, are related to (a) differences in absorption (b) rates of removal from the tissues and (c) amounts entering the brain and fetus. Important information on these differences has been obtained in animal studies. Since this information has helped us to understand the effects of methylmercury in man, I will describe some of these studies.

Studies with inorganic mercury salts show that these are less well absorbed than organomercurials. In the case of inorganic mercury, absorption from the GI tract has been estimated to be as low as 2 percent,whereas in the case of methylmercury intestinal absorption in experimental animals and man is more than 90 percent. The rate of metabolism of organic mercurials to inorganic mercury appears to be an important factor in determining tissue distribution and rates of excretion.

Studies with experimental animals have shown that aryl mercury compounds are absorbed unchanged into the blood stream with about 50 percent being bound to the red blood cell. It is mainly removed by metabolism in the liver and kidneys and excreted into feces and urine largely as inorganic mercury. In rats, intact phenylmercury was only detectable for four days.

In similar studies with methylmercury, more than 90 percent of the absorbed methylmercury was bound to red blood cells and intact methylmercury was present 21 days after the original exposure. Methylmercury is excreted largely by the intestines and is partly metabolized to inorganic mercury.

The slow metabolism and excretion of alkyl mercurials as compared to the rapid metabolism and excretion of phenyl mercurials is reflected by the long time period in which the body continues to accumulate methylmercury as compared to phenylmercury. For example, studies with experimental animals, rats, which were injected daily with phenylmercury showed that a steady state, that is, excretion balanced by intake, was obtained within two weeks. No significant amount of mercury was found in the brain.

Dr. S. I. Shibko

Similar studies with rats exposed to methylmercury showed that there was no indication of steady state after a period of six weeks, that is, the test animals continued to accumulate methylmercury in the body. In contrast to studies with phenylmercury, methylmercury was accumulated in all tissues, particularly in the red blood cells and the brain, although there is a considerable time lag in the entry and distribution of methylmercury into the brain. Administration of low doses of methylmercury for long periods of time will result in equilibrium being established. It has also been shown that in the case of methylmercury the amount of mercury accumulating in the body is directly related to the dose size.

Another important concept that has been developed with the use of experimental animals is that a critical concentration of mercury in brain tissues is required to produce neurological symptoms. Because it will require some time for the brain tissue of exposed individuals to reach such levels due to the time of passage through the blood brain barrier and redistribution of mercury in the brain, neurological symptoms are not observed during the early periods of exposure, but may develop several weeks after the initial exposure. However, it has been established that toxic concentrations of methylmercury in the brain vary very little between different animals. In all mammals, concentrations of 5 to 10 µg/g brain tissue may be associated with neurological symptoms.

As regards congenital poisoning, studies with experimental animals show that methylmercury in contrast to other mercurials crosses the placental barrier and appears to have a greater affinity for the central nervous system of the fetus than that observed in the adult.

The effect of methylmercury as a mutagenic agent is also of concern. Chromosomal aberrations have been caused in plants and insects by mercurials and chromosomal aberrations of lymphocytes from individuals exposed to high levels of mercury-contaminated fish have been observed. At present the significance of these changes is not fully understood.

These studies provide some information to better our understanding of the effects of methylmercury in man, but in no way can be considered adequate to resolve the many areas of uncertainty that still exist when considering this problem. In any evaluation of an acceptable intake of a food additive, great importance is attached to data derived from studies with experimental animals, as data from controlled experimental studies with man are rarely available.

I have some slides that I would like to show at this stage which will help to explain how we have been able to evaluate some of the problems associated with mercury residues in fish.

These slides relate to the types of information normally available for evaluating the safety of food additives or residues and those that are available for establishing the FDA guidelines for mercury. The information available on these slides will be made available for the record.

(The above-mentioned slides follow:)

SLIDE I.

Types of data normally available for estimating acceptable daily intake of Intentional Food Additive.

Acute Toxicity - Many species.

Sub-Acute Toxicity Studies.

Chronic Toxicity Studies.

Reproduction Studies.

Biochemical and Metabolic Studies.

SLIDE 2.

Data Available for Establishing the Interim FDA Guidelines for Mercury in Fish.

1. Estimates of Levels of Intake of Contaminated Fish and Shellfish in Minimata Episode (Swedish Official Evaluation November 1967).
2. Intake of methyl mercury and body levels of methyl mercury.
   - (a) Intake of methylmercury in man from contaminated fish and blood levels of mercury.
   - (b) Studies on distribution and excretion of Hg 203 labelled methyl mercury in a few human volunteers. Data on brain levels of mercury in test animals and human autopsy cases.

SLIDE 3.

Estimation of Acceptable Intake Based on Information Derived from Minimata Poisoning Episode

(Original Swedish Evaluation)

Affected individuals ate generally daily fish and shellfish with a mercury content of 27 - 102 ppm (average value 50 ppm).

Since this is a toxic level, a decrease to 1/10 of these values, i.e. to 5 ppm should prevent appearance of poisoning.

A further decrease by 1/5 or 1/10 of mercury content to 0.5 - 1 mg/Kg fish, should exclude influence by methylmercury.

SLIDE 4.

This estimate was based on mercury content of dried fish, which introduces an additional factor of at least 2.5 (or more reasonably 5).

The evaluation should have been based on fresh fish with a mercury content of 10 - 40 ppm. Using the above factors, this would give a safe level of 0.2 - 0.4 ppm (factor of 2.5).

Estimated intake of fish in Japan was 200 g/day, as compared to U. S. average of 40 g/day.

SLIDE 5.

2A. Estimate of Acceptable Intake Based on Swedish Data Relating to Consumption of Contaminated Fish.

1. Mercury in edible muscle is in the form of methyl mercury (U.S. and Swedish studies).

   Birke (1967) reported mercury levels in blood and hair of Swedish individuals eating contaminated fish. Maximum intake of methyl mercury reported was equivalent to 1 mg Hg/day.

   (150 g fish containing 6.7 ppm Hg).

   No adverse effects were reported.

   If we accept this as a no effect level for man, then using a safety factor of 10, an acceptable daily intake of mercury would be 0.1 mg.

SLIDE 6.

The margin of safety represented by this estimate is questionable because:

1. Mercury level in blood of the individual (650 ppb) is half that of a reported Niigata victim (1300 ppb).

2. Recent studies have demonstrated that cultured lymphocytes from this individual show chromosomal abnormalities.

3. It would be unwise to evaluate health risks on such limited data (experience of a single individual) as no allowance is made for individual variation, especially for more sensitive individuals.

SLIDE 7.

Estimate of Acceptable Intake Based on Excretion of Labelled Methyl Mercury.

1. Biological half life of Methyl Mercury in Man = 65 - 74 days = daily excretion of 1 percent of total body burden (Ekman et al, 1968).

2. Distribution of Radioactive Methyl mercury in man (by whole body scanning) showed 13 - 22 percent located in head (approximately 20 percent) (Ekman et al, 1968).

3. Studies with laboratory animals and of human autopsy tissue indicate concentration of mercury in brain which causes toxicity is 8 μg/g. (Berglund and Berlin, 1969).

SLIDE 8.

Based on these observations, the following calculations were made (Berglund and Berlin, 1969).

(a) Total amount of mercury in adult brain at toxic concentration = 8 µg x 1500 = 12 mg Hg.

(b) Total body burden (based on 20 percent of total body burden in brain) = 60 mg Hg.

(c) Daily excretion of 1 percent of total body burden, or daily intake of methylmercury to maintain equilibrium - 0.6 mg Hg/day.

(d) If this represents minimum toxic chronic dose to adult man, applying safety factor of 10, ADI would be 0.06 mg Hg/day.

SLIDE 9.

More Recent Swedish Data

Data based on relationship between methyl mercury intake (contaminated fish), and review of available epidemiological data from Niigata episode:

(a) Lowest Hg level in whole blood associated with clinically manifest signs of poisoning in Niigata episode was 0.2 µg/g (200 ppb).

(b) Relationship between mercury levels in blood and methylmercury intake (derived from Tejoring's data) intake of 0.3 mg Hg/day gives rise to blood level of 0.2 µg Hg/g (for 70 Kg individual). Using safety factor of 10, an acceptable level for whole blood is 0.02 µg Hg/g; and an acceptable daily intake of methyl mercury through fish would correspond to 0.03 mg Hg, or 30 µg methyl mercury for a 70 Kg individual, or 0.4 µg/Kg body wt/day.

SLIDE 10.

Need for safety factor of at least 10.

1. Estimates of an acceptable daily intake are based on lowest estimated dose that causes an 'effect', rather than normal procedure of using a 'no effect' dose level.
2. Many areas of uncertainty:
   (a) Variation in individual sensitivity.
   (b) Dose response relationship in pre - and post natal life.
   (c) Genetic effects.
   (d) Effect of chronic exposure to low levels of methyl mercury.

Dr. S. I. Shibko

DR. SHIBKO: The types of data normally available for evaluation of the safety of food additives are on the first slide. They include acute oral toxicity in many species in order to determine the LD_{50}, subacute studies in at least two mammallian species. These short-term studies, although providing information on dose effect relationships, do not provide satisfactory data on life expectancy or carcinogenicity. Chronic studies will be required to establish maximum dosage tolerated for a lifetime without discernible hazard. In addition, multigeneration reproduction studies are required and also biochemical and metabolic studies.

Based on such studies, an acceptable level for man is 1/100 of the no effect level for the most sensitive species. If adequate human data are available, then a safety factor of 1/10 is generally considered acceptable, because no factor is needed for species differences. Information on the daily intake of the foodstuff containing the additive enables us to estimate the maximum permissible level in that foodstuff that will not cause the acceptable level of intake to be exceeded.

Many of these data are not available for mercury. Further, although the toxicological effects of mercury depend on the chemical form of the compound, namely, inorganic, alkyl, alkyoxy or phenyl, in the case of fish, our prime concern is with methylmercury, which has been shown to be the most toxic form of the mercurials. The types of data available for establishing the interim FDA guideline for mercury in fish are shown in the second slide.

There are essentially three types of data available. First the estimates of levels of intake of contaminated fish and shellfish in the Minimata episode; secondly, intake of methylmercury and body levels of methylmercury. These were derived from (a) intake of methylmercury in man from contaminated fish and blood levels of mercury; and (b) studies on distribution and excretion of mercury 203 labeled methylmercury in a few human volunteers. And also the data on brain levels of mercury in test animals and human autopsy cases.

Slide 3 shows an estimation of the acceptable intake based on information derived from the Minimata poisoning episode. This was the original Swedish evaluation.

Affected individuals ate generally daily fish and shellfish with a mercury content of 27 to 102 ppm, with an average value of 50 ppm.

Since this is a toxic level, a decrease to 0.1 of this value, i.e. to 5 ppm, should prevent the appearance of poisoning.

A further decrease by 0.5 or 0.1 of mercury content to 0.5 to 1 mg/Kg of fish should exclude influence by methylmercury.

However, these figures used for the levels of mercury in fish were based on a dry weight. Kurland in 1960 suggested a factor of 2.5 for comparison of dry weight to water weight. However, such a factor would suggest shellfish contain only 60 percent water. A more realistic estimate of 80 percent would introduce a factor of 5 and the safe level would be 0.1 to 0.2 ppm, as shown in the next side.

Slide 4, please.

This estimate from the previous slide was based on mercury content of dried fish, which introduces an additional factor of at least 2.5 or more reasonably 5. The evaluation should have been based on fresh fish with a mercury content of 10 to 40 ppm, which, using the factors in the previous slide, would give a safe level of 0.2 to 0.4 ppm. The estimated intake of fish in Japan was 200 grams per day and this compares with the U. S. average of 40 grams per day.

Burke has studied a number of Swedes who over long periods of time ate contaminated fish containing various amounts of mercury. They ate the fish from daily to once a week. One subject with no reported symptoms of methylmercury poisoning consumed methylmercury through fish equivalent to 1 mg Hg/day.

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This information is contained on the next slide, Slide 5.

At that time it was suggested this intake of mercury was a "no effect dose in man," and Berglund and Berlin in 1969 used this data as one possible method for determining an acceptable daily intake of methylmercury.

The mercury in edible muscle is in the form of methylmercury. This has been clearly shown in United States and Swedish studies. Burke reported mercury levels in blood and hair of Swedish individuals eating contaminated fish. The maximum intake of methylmercury reported was equivalent to 1 mg Hg/day. This was obtained by consuming 150 grams of fish containing 6.7 ppm of mercury. At that time no adverse effects were reported. If we accept this as a no effect level for man, then using a safety factor of 10, an acceptable daily intake of mercury would be 0.1 mg.

However, the margin of safety represented by this individual is questionable, as shown in the next slide.

The mercury level in the blood of this individual, 650 ppb, is half that of a reported Niigata victim, which was 1,300 ppb.

Recent studies have demonstrated that cultured lympocytes from this individual show chromosomal abnormalities.

And finally, it would be unwise to evaluate health risks on such limited data based on the experience of a single individual, as no allowance is made for individual variations, especially for more sensitive individuals.

The metabolism and retention of methylmercury 203 nitrate in human volunteers, as well as data derived from experimental animals and autopsy data from man, which have shown that the lowest level of mercury in the brain which is required for manifestation of clinical symptoms is relatively constant, has also been used as a basis for determining an acceptable daily intake of mercury. These data are summarized on the next slide, Slide 7, please.

The biological half-life of methylmercury in man is equivalent to 65 to 74 days. This is equivalent to a daily excretion of 1 percent of the total body burden.

Studies on the distribution of radioactivity of methylmercury in man, carried out by whole body exchange, showed that 13 to 22 percent is located in the head, that is approximately 20 percent.

Studies with laboratory animals and of human autopsy tissues indicate that concentrations of mercury in the brain which causes toxicity is 8 µg/g.

The next slide, please.

Based on these observations, the following calculations were made:

The total amount of mercury in adult brain at toxic concentration would be 8 µg x 1500, 1500 grams being the average weight of the human brain. This would mean 12 mg Hg.

The total body burden based on 20 percent of total body burden in the brain would be equivalent to 60 mg Hg, essentially five times that present in the brain.

The daily excretion of 1 percent of total body burden, or the daily intake of methylmercury to maintain equilibrium, would be 0.6 mg Hg/day.

If this represents minimum toxic chronic dose to adult man, applying a safety factor of 10, an acceptable daily intake would be 0.06 mg Hg/day.

Recently Swedish data, based on a review of the available data from the Niigata episode, and the direct relationship between methylmercury intake and blood levels of mercury, derived from the data of Tjening, is summarized in Slide 9.

In this study the information from the Niigata poisoning episode showed that the lowest mercury level in whole blood associated with clinically manifest signs of poisoning was 0.2 µg/g or 200 ppb.

Studies on the relationship between mercury levels in blood and methylmercury intake derived from Tjening's data, which essentially derived from the study of methylmercury intake by contaminated fish in blood levels in Swedish individuals, showed that an intake of 0.3 mg Hg/day gives rise to a blood level of 0.2 µg Hg/g for a 70 Kg individual. Using the safety factor of 10, an acceptable level for whole blood is 0.02 µg Hg/g and an acceptable daily intake of methylmercury through fish would correspond to 0.03 mg Hg, or 30 µg methylmercury for a 70 Kg individual or 0.4 µg Hg/Kg body weight per day.

May I have the next slide, please?

It is recognized that the information on which these estimates are based is incomplete. One unfortunate feature of all these evaulations is that the estimates are based on the lowest estimated dose that cause an effect rather than the more normal procedure of a no effect dose level.

Further, as shown in the next slide, there are many areas of uncertainty and the magnitude of the safety factor used in these estimates may provide a sufficient margin of safety. Included in these areas of uncertainty are:

Variations in individual sensitivity.

Dose response relationships in pre- and post-natal life.

Genetic effects, and

Effect of chronic exposure to low levels of methylmercury.

That is all for the slides.

A major factor relating to the level of exposure is concerned with (a) the normal level of intake of fish with the United States, and (b) mercury from other dietary items, i.e., the normal level of mercury in food, and (c) the possible inclusion into the diet of foods that may have become contaminated through the misuse of mercurials, e.g., contaminated meats or eggs, following feeding of treated seeds to domestic animals and game birds eating treated seeds. Some of these aspects of the problem will be dealt with by other speakers.

Finally, there is the question that is often asked, namely: Is the bound methylmercury in fish as toxic as the chemical form of methylmercury? Studies in Sweden, where experimental animals were fed either fish containing natural methylmercury residues or non-contaminated fish to which methylmercury had been added, showed that each batch of fish was equally toxic.

MR. DICKSTEIN: Thank you, Dr. Shibko.

We would now like to hear from Mr. Richard Ronk, FDA, Chief of the Guidelines Branch and Mercury Program Manager.

Mr. Ronk.

RICHARD RONK, CHIEF
GUIDELINES BRANCH, BUREAU OF FOODS
FOOD AND DRUG ADMINISTRATION
WASHINGTON, D. C.

MR. RONK: I just have a few remarks and I think I will limit them after Dr. Shibko's toxicological presentation.

The administrative officials and the Commissioner of the Food and Drug Administration, taking this information into effect, established a guideline for mercury in fish flesh in July of 1969. This was much before there was any hysteria about mercury in our environment. This guideline has been reestablished twice since then after complete and exhaustive toxicological review.

We have in our opinion exhausted the toxicological information, both published and unpublished, in the world. We have made separate trips to all of the eastern European countries where there is some work being done and also to Japan to talk to the people that are involved with these problems.

It is true that there are no demonstrated poisoning incidents resulting from fish flesh in the United States. We would hope that this would always be the case. We do not recognize that there is any risk-to-benefits ratio in foods and that is why we establish the most conservative safety factors that we can. In this particular instance the safety factors are not as broad as we would like them to be.

The guidelines are established on the basis of the dietary intake, total exposure. If we establish a guideline for commercial fish at a 0.5 ppm and there is a significant exposure elsewhere in the diet, then the guideline is compromised and the safety factor is reduced.

We don't feel that in a situation such as we have here in South Dakota that the toxicological information is the most important from our standpoint. Let me explain why this is true.

The black bound report that you have before you is a fairly good inspectional technique to demonstrate fairly conclusively, using the ordinary court definitions of evidence and proof, that a poisonous material was added to the fish. We would charge under the Food, Drug and Cosmetic Act, Section 402(a)(1), that this is an added poisonous deleterious substance. The proof, then, for us only becomes: Is the substance added? Is it poisonous and deleterious? At that point we can take legal action against that food.

If fish were shipped from the reservoirs in South

Dakota to Canada, as apparently they have been, or to other parts of the United States, we would initiate regulatory action against those fish. We would seize them and remove them from the market. If a person persisted in this and the Denver Regional Office would recommend prosecutions of the individuals involved, we would also consider criminal prosecution against the individuals who shipped fish. This is the same attitude that we would take toward any food shipped in interstate commerce that contains a poisonous deleterious substance.

If the courts would decide that the substance is not added and then we would have to drop the word "added," we would be willing to allege under the same section of the Act, 402(a)(1), that the methylmercury is in the fish, is a poisonous deleterious substance and it does render the food injurious to health under the ordinary conditions of use.

Ordinary conditions of use as far as diet is concerned varies considerably with individuals. We have diets in the United States that are ethnically related; we also have diets in the United States that relate to cultural influences, such as weight watching diets. We would consider people who consume large quantities of fish to be getting into a risk category and we would evaluate the risk on the basis of the total consumption of fish and the levels of methylmercury that were found in this flesh.

The guideline is simply our interpretation at what level we are willing to take action under the Act. We are willing to contest these features in court and we expect that we will have to.

If there are any questions, we will be glad to try and answer them.

MR. STEIN: Any comments or questions?

Let's see if I understand it. You have 0.5 in fish but that just deals with fish and not the rest of the diet. In other words, if mercury is coming in from other sources, that might be hypercritical?

MR. RONK: Well, at the time that the Commissioner made a press release on swordfish and what has been called the swordfish ban in the United States, we called together, for the third time that I am aware of, all of the people that we could gather that had information to offer on this subject and at that time they evaluated what was in the food supply. The United States Department of Agriculture has run a 3,000 steer survey, for instance, to determine what the mercury content of meat is, and we could make that available to you. It is very, very low. Which is a very important factor because that is a very large part of our diet.

We also took into consideration special economic studies that the National Marine Fisheries Service had carried out to try and find out if there were patterns of fish consumption in the United States that were away from the average, and we found that there were. For instance, where most people would not consume a swordfish meal in a year, there were many people that consumed as many as 26 or 30 swordfish meals in a year. Economically it was upper middle class people of a certain ethnic group from New York State.

So all of these factors are taken into consideration. There are no significant methylmercury burdens to the American consuming public except from marine species.

Now, if you take a 1 ppm average fish, like swordfish, it was considered that this was far too great an invasion of the safety factor to allow this commodity to stay on the market. And so at that time Dr. Edwards took steps to issue a press release and warn the public about the consumption of swordfish. Most swordfish is imported to the United States, so it is a fairly easy task to stop it at the ports of entry.

If someone consumes large quantities of fish, let's say tuna fish, at 0.3 and consumes large quantities of sport or recreational fish that may be running from 0.3 to 0.6 or 0.8 and he also consumes game birds, we feel that there are circumstances where these individuals might be able to work themselves into toxicological problems.

Would you disagree with that, Dr. Shibko?

DR. SHIBKO: No; I agree.

MR. RONK: So that is the terms of the potential health problem that we see.

And with that, I wonder if that answers the question.

MR. STEIN: Yes. Well, I wonder if you can answer this as an opinion question, Mr. Ronk.

You have read and heard the black report. You have seen the amount of mercury that comes out in the environment in this area and in ubiquitous fashion. If you were living in this area would you be tempted to eat sport fish that would have a mercury content of 0.5?

MR. RONK: Well, let me say this. The Food and Drug Administration when it found that 15 percent of the tuna fish consumed in the United States might contain residues at a half a part per million, which is the same figure almost essentially that you had on the report here, they decided to spend their entire resource to analyze the entire tuna fish catch of the United States. This involved three shifts in 17 laboratories; this involved the use of 446 analytical chemists plus inspectors; it also included all of the resources of all the tuna canneries in the United States, 14 of them, and used up any analytical facility that could be found in the United States for this particular job. That is how serious we saw this if it were going to be a generalized part of the American diet.

If these fish are food fish and if we would expect them to be consumed to any degree by the citizens of South Dakota, we would--if it were our problem this might be our response.

MR. STEIN: Doctor?

DR. HAYES: I would like to ask a question.

I understand the problems of setting a level to try to insure safety for the public and appreciate Dr. Shibko's report and the work that the FDA has done.

I as a physician have a question which plagues me deeply, and it has plagued all my fellow physicians a great deal, because we are charged with the responsibility of taking care of those who have had trouble with mercury or any other toxin. And in my particular branch of medicine I am charged with the responsibility of preventing it.

I have been searching the literature for some time, and as near as I can tell at this time the only reported case I have available to me in the United States from eating shellfish or seafood is the one case of swordfish poisoning that was alleged. Is that right as far as you know?

MR. RONK: That is right.

DR. HAYES: Again I am puzzled with the thing. We are talking in terms of theory, I realize, and one has to do that, but somewhere along the line I think it would be more practical for not just the industry involved but the public as a whole, somebody has to say, well, what has happened in the case of poisoning in the numbers of people.

I noticed in your presentation, Dr. Shibko, that a group of volunteers had been given certain amounts of methylmercury. And it would seem almost practical somewhere along the line we would have to do that and tag this thing radioactively and be able to find out what has happened. Apparently that is being done but there is not enough information known about it.

DR. SHIBKO: This is being done, but only extremely small amounts of methylmercury were used in these studies.

DR. HAYES: I would appreciate that.

DR. SHIBKO: I think that what is more important is that there is a great deal of research going on as to what would be the most sensitive diagnostic technique to determine possible subclinical effects and the effects that might be due to low levels of exposure. This is the area in which most of the work is going on.

DR. HAYES: I would agree with that too. I mean somewhere along the line to get some hard data we simply have to do it.

My reason for asking this, I am sure you know Dr. Hochberg from the National Communicable Disease Center at Atlanta, a brilliant young neurologist. I know you know him.

DR. SHIBKO: Yes.

DR. HAYES: And I know that you know that he spent some time in the Aleutian Islands where he lived with the Aleuts for some period of time, and these folks were known to have high levels of mercury in hair, blood and urine. As a matter of fact, in talking with Dr. Hochberg personally, and even in his written communications, he points out that the levels that were determined that those people had and lived with daily would be enough that all of them should either be dead or paralyzed, but none were. I think this gets back to your statement about the dosage, in other words, how long a time you get it, how it is built up, and so forth.

DR. SHIBKO: I think in this particular form there is also the question of what is the form. These people were eating seal liver, and only a portion of the mercury in seal liver is in the form of methylmercury. It may be mainly in the form of inorganic mercury.

DR. HAYES: But again I think it brings up the point that here we have a group of people with a known ingestion and by our standards of levels of blood, urine and hair far exceed the limits we talk about as being toxic and yet these people obviously are not dead or paralyzed.

DR. SHIBKO: Well, that is true. And I think that they are continuing to look for populations that may have been exposed to methylmercury through fish so it might be possible to work out diagnostic techiques to see if anything has happened.

MR. RONK: I think also the time has come that we really should quit talking in terms of mercury in relation to toxic phenomena. As far as fish flesh is concerned, and we have carried out extensive tests on a number of species to be sure of this fact, fish flesh is methylmercury. The order of toxicity is so great that the others are not even in the same ball park. When we talk in terms of seal livers and other portions of aquatic animals, this is where, as Dr. Shibko's testimony pointed out, phenylmercurial compounds will concentrate. You can also have an exposure of phenylmercurial compounds in drugs. You can also have an exposure from cosmetics; these are used as preservatives in cosmetics. As Dr. Shibko has also pointed out, the excretion of these materials is much quicker and the toxicological burden to the individual is much less.

In discussing with Dr. Hurdman from the New York State Health Department, who announced the Mrs. Y, the swordfish person, before the Senate Commerce Committee, if this woman was--she ate considerable amounts of swordfish in fad diets and she would go on crash diets and lose 35 pounds at a time. She did this over a period of several years. If she was in fact poisoned from eating swordfish, I think it is significant that one of the leading neurological hospitals in the United States was unable to diagnose this particular phenomenon. This is why I agree with Dr. Shibko's assessment and Dr. Clarkson's assessment from the University of Rochester Medical School in New York that one of the principal needs of the medical profession at the present time is the technique to be able to diagnose the subclinical effects of mercurial poisoning.

The other thing that impresses me as a layman in talking with the toxicological experts is that they point out that the brain can withstand tremendous challenge before symptoms are produced; and that in Dr. Clarkson's opinion methylmercury and fish flesh may be very well involved in the process of aging; and that the principal effect on human beings may be that a man when he reaches 60 years old will have a 70-year-old brain, and he at this time will need the extra capacity to withstand some other challenge to his health.

I think as we go on and as we develop more sensitive techniques we will find many other phenomena that are associated with health and our diets that are quite in the same ball park.

MR. STEIN: There is one point in Mr. Ronk's and Dr. Shibko's analysis that interested me, Dr. Hayes. This is the point I have because I am with you and I have worked with the Public Health Service for years. I know the problem we have with these safety factors, the arbitrary figure of 10, looking for clinical records.

But I would like to call your attention to page 5, and I think this is critical, that first full paragraph. It says, "At present there are no sensitive diagnostic techniques to identify possible subclinical and latent mercury toxicity." That fits in with what you said. "Of particular concern in relation to possible undetected injury are reports that individuals who have been exposed to methylmercury, or alkyl mercurials, may continue to function in an apparent normal manner and then at death, some years later, show the complete pathologic brain lesions associated with the exposure."

I think I have tried to read the literature too, and even though I am, as you know, a lawyer in this business, I think I have come to the same conclusion. The question here is if we do not get the normal clinical relations, effects that you indicated; if we don't detect this clinically and after death we find the pathological brain lesions associated with exposure; if this can be documented; if this is an accurate statement--can we, with complacency, accept that? Now, this is the question I raise.

DR. SHIBKO: This can be well documented. There are cases from Germany where people were exposed to alkyl mercurials in industry and functioned fairly well for a number of years; and then when they died, it was found that their brain was very badly damaged. And there are also some cases from Japan in the Minimata episode where people seemed to have gone on very well for a long period and then died very suddenly. Then on autopsy it was found that their brains were pretty badly damaged.

DR. HAYES: I am familiar with those cases, although not the ones from Germany. My point is I am sure that as we go along we could find--and I am just guessing and I am going to take a wild guess--at least 200 compounds, elements or combinations that might do the same thing. I am sure that we get into this area, for example, where we are talking about the things you deal with every day of new drugs and new substances which are being produced and you have to try to prevent any trouble before it happens, thinking back to the terms of the thalidomide disaster, for example, and fortunately one of our good doctors was able to at least see to it to hold back a while before we authorized the sale in the United States and it was prevented. I think many things may turn up.

My point is here we are talking about something, as you point out, Mr. Ronk, is a food substance and is a part of diet, etc., and I think that you can at least put that in another category than cosmetics or thalidomides or those sort of substances. Of course it is that very thing that got us together today. You see, we have to get back to the Governor's challenge or the Governor's charge again to say, at least to help me, is there an immediate toxic problem in South Dakota or is there a potential one? As I said this morning, I am willing to agree there is a potential one. I think the evidence all points to that. But my problem is--and I think you are asking me to make this today by saying we have to put a sign up on the Cheyenne Arm of the Oahe Reservoir, "Don't eat the fish." And I think that gets back to your statement, Mr. Chairman, that you didn't know whether you would do that or not if you were in South Dakota. Well, I am not too sure either. But this is the kind of help we need to do.

I am not certain that even as a panel or as a group we will be able to come to a conclusion that will have enough weight to make this decision for the rest of the world. I don't mean that. But it would help me if we could, because then I would know which way to go. But right now we are taking a lot of action and proposing a lot of action on the basis of something that we are not certain about at all.

MR. RONK: What type of a response would--how would you differentiate the response between a potential and immediate health hazard, as far as the step that you might take?

DR. HAYES: I think my example is probably the one I mean, Mr. Ronk. In other words, do I tell people not to eat the fish in the Oahe Reservoir or do I not? I would say if I had an immediate toxic problem of mercury to people who ate those fish,I would tell them not to eat those fish. And if you recall, last summer when this came up and without benefit of advice or consultation except from my own staff and what I could read,I had to say go ahead and eat those fish. That is what I mean by immediate or--in other words, compared to potential.

MR. STEIN: That is why I asked Mr. Ronk the question. And by the way, I don't want to put you on the spot. But the question I asked was, in your opinion, after reading the black report and looking this over, whether you would eat the fish in the river there if you knew--and let's make the supposition--

that you had 4.5 points of mercury, whether you would eat a game fish which you knew might have that.

The point is, I think as administrators we have to get an answer to that--

DR. HAYES: That is right.

MR. STEIN: --if we are going to know how to proceed with the next step. I believe we have two propositions. If I think I understand Dr. Hayes correctly, I have heard no opposition to moving as rapidly as we can in an orderly manner to reduce mercury to the lowest reducible limit, the lowest absolute limit.

Given the present situation, the question here is, do you take more drastic action in the interim or not? This is a question of balancing--whether there is a present danger or a potential danger.

MR. GRIMES: Mr. Chairman.

MR. STEIN: Yes.

MR. GRIMES: I think you have to add one more variable to give a fair question to the gentleman. How much is he going to eat?

MR. STEIN: Well, no, the variable I gave him--I am sorry, maybe I didn't make this clear. I will repeat it. I think you are right. I said, living in this area and knowing the ubiquitous character of mercury in this area, wherever it may be--I don't know whether it is ubiquitous, but it is around in the streams--would he catch a walleye and eat it? Now, my coming in from another area and eating the fish here wouldn't be too bad, but let's suppose he were a resident of this area. I think that is the question. Those are the guys that catch the fish. I don't know the answer to that question.

MR. RONK: Well, actually my own personal feelings toward it really are very irrelevant. There was a fellow that was Assistant Secretary of HEW who said that he would drink cyclamate pops and thought that they were wonderful and the next day they took them off the market.

MR. STEIN: Who, the Assistant Secretary or the pop? (Laughter.)

MR. RONK: I believe both are off the market now.

DR. HAYES: Both. (Laughter.)

MR. RONK: But I think the answer as far as FDA's position, what FDA would do about it, is, in effect, that if these fish from this same place are shipped in interstate commerce and we find them above the guideline, we will seize them so that we would keep the rest of the country from eating these same fish.

There are many steps that I think the States can take and there are many levels of response other than the recommendation that is in the black book to these things. Our response to the tuna fish was a total analysis program. And once we found that the levels in the tuna fish were manageable from the standpoint that quality control programs could be initiated that related to size and species, this is another type of response to this. It may very well be that you might be able to do something along those lines.

MR. STEIN: I think you can answer this question, and I don't mean this to be invidious in any way. I just opened the book, this is the black book, page 29. It says:

"Samples of fish collected from the Cheyenne Arm of Oahe Reservoir by the United States Fish & Wildlife Service and analyzed by EPA personnel generally contained high mercury concentrations, many of which exceeded the guideline."

Then it goes on:

"Mercury concentrations exceeding 0.5 ppm,were detected in the flesh of northern pike, walleye, sauger, white bass, black crappie, channel catfish, freshwater drum, shovelnose sturgeon, carpsucker, carp, and bigmouth buffalo."

O. K. Now, what Mr. Ronk has said, as I understand it, if these were shipped commercially and could be bought commercially and were shipped in interstate commerce, he would seize them and would not let them be sold. Is that correct?

MR. RONK: That is right.

MR. STEIN: The question that you are asking, Dr. Hayes, is since they are being caught locally, as the swordfish, should you let the people eat them.

DR. HAYES: That is correct.

MR. STEIN: But I think we have his answer. His answer is that if these were commercial fish and shipped interstate, he wouldn't let them go.

I think that is a correct statement.

MR. RONK: That would be the Commissioner's decision.

MR. STEIN: Right. But generally--I know you don't like to speak for your Commissioner, as I don't--but this is the way I understand--

MR. RONK: That is right.

MR. STEIN: --the law.

Now, are there any other comments or questions?

If not, thank you very much.

MR. DICKSTEIN: Here is the addendum[*] to the black book.

I would like to call on Dr. Milton Lammering, of the Division of Surveillance Analysis, Region VIII, Denver.

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[*] See page 22A

Dr. Lammering.

DR. MILTON W. LAMMERING, SANITARY ENGINEER
DIVISION OF SURVEILLANCE AND ANALYSIS
REGION VIII, EPA, DENVER, COLORADO

DR. LAMMERING: My name is Milton Lammering. I am a sanitary engineer with the Environmental Protection Agency, Region VIII, Denver, Colorado.

Just as a joke here, that is the first time I have said that. I have been saying Cincinnati, Ohio, for 12 years and I thought I would mess it up, but I didn't.

Mr. Chairman, I have a prepared report entitled "Evaluation of the Impact of the Mines Development, Inc., Mill on Water Quality Conditions in the Cheyenne River," and I would like to have this put into the transcript as if read.

MR. STEIN: Without objection, this will be done.

(The above-mentioned report follows:)

EVALUATION OF THE IMPACT
OF THE
MINES DEVELOPMENT, INC. MILL
ON
WATER QUALITY CONDITIONS IN THE CHEYENNE RIVER

ENVIRONMENTAL PROTECTION AGENCY
Region VIII
Denver, Colorado

September 1971

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I. INTRODUCTION

An intensive water quality study of the Cheyenne River and the tributary stream, Cottonwood Creek, in the environs of the Mines Development Mill located at Edgemont, South Dakota, was conducted by EPA personnel[1] during July 26-30, 1971. The objectives of the study were to determine and evaluate:

1. Water quality conditions in Cottonwood Creek and the Cheyenne River during a period of dry weather flow.
2. Chemical and radioactivity loadings (mass/day) on Cottonwood Creek and the Cheyenne River as the result of seepage from mill ponds.
3. Radioactivity levels in the water, biota and bottom sediment of Angostura Reservoir.

The July study was conducted at the request of the South Dakota State Department of Health. In this respect, the study represented a continuation of the support provided to the State in its long-term program to monitor and assess the environmental impact of mill operations. Mines Development personnel were most cooperative in providing the field team with unlimited access across mill property and bench space in the mill laboratory.

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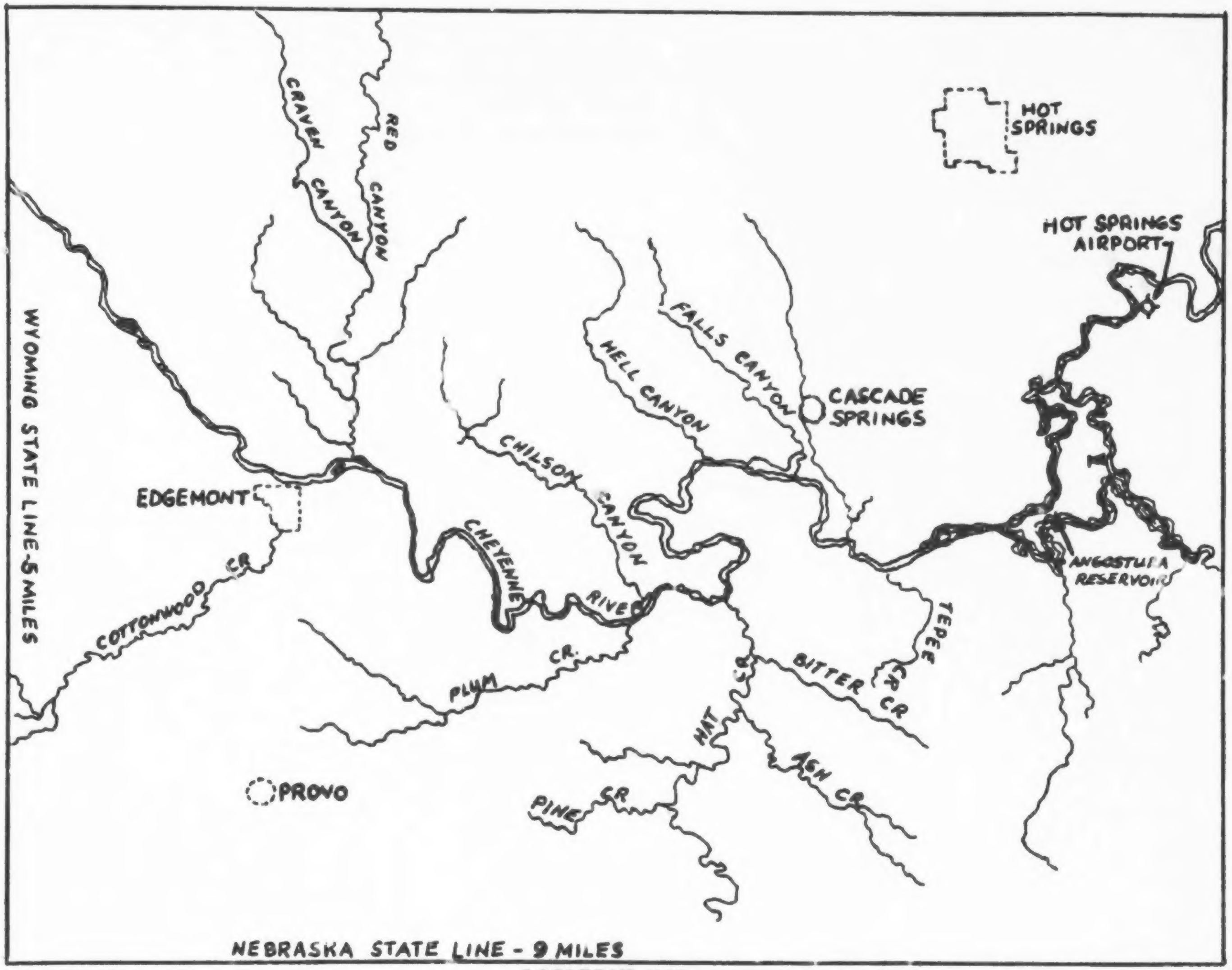
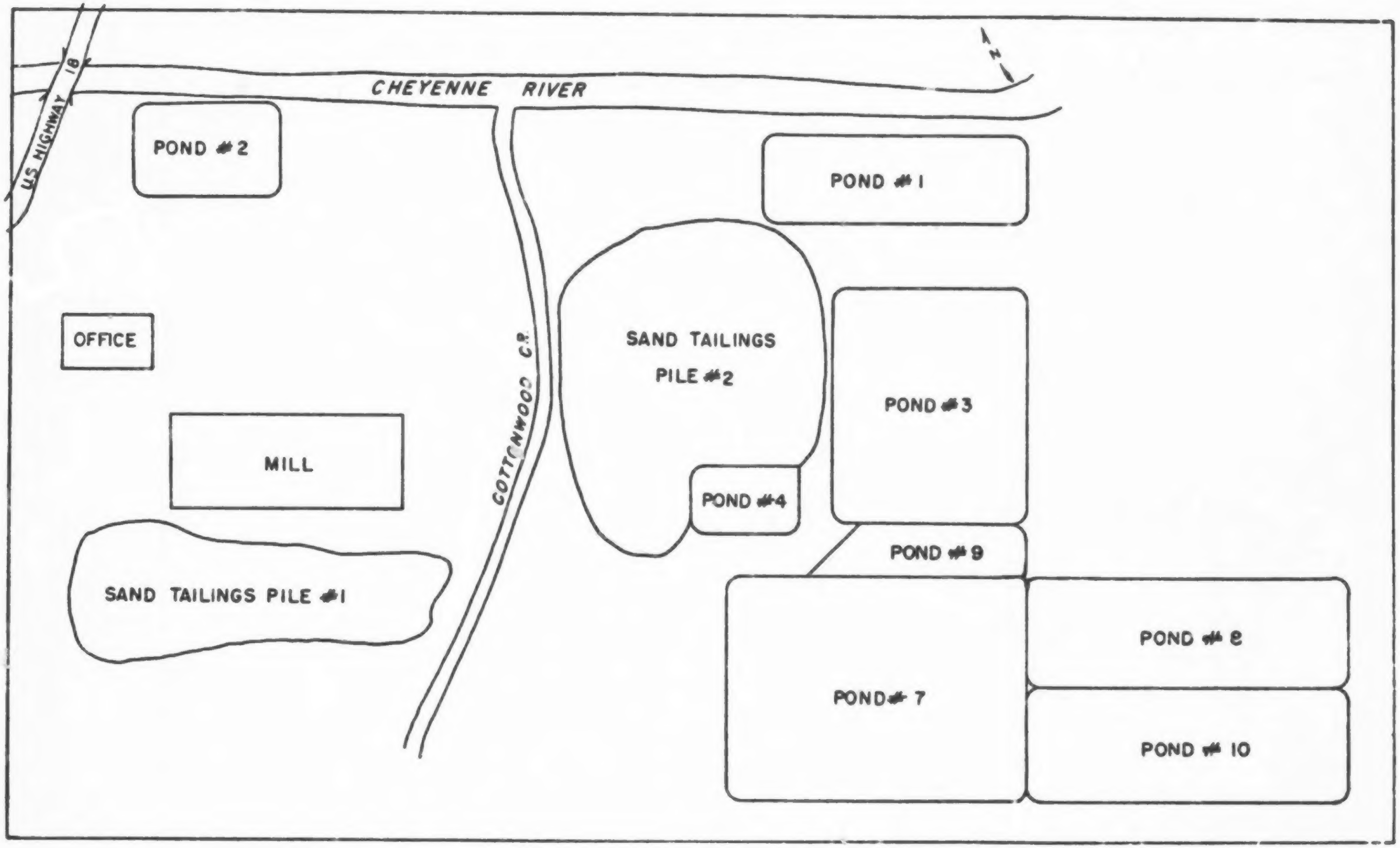
[1] Radiological Activities Section, Division of Technical Support, Office of Water Programs, Cincinnati, Ohio

The "Edgemont" mill is operated by Mines Development, Inc., a subsidiary of the Susquehanna Corporation. As shown in Figure I, the mill is located in the southwest corner of South Dakota on the south bank of the Cheyenne River. A tributary to the Cheyenne River, Cottonwood Creek, traverses the mill property and is flanked on both sides by inactive sand tailings piles (Figure 2). Angostura Reservoir, a recreational lake, is located about thirty-five miles downstream near the city of Hot Springs.

Mineral processing operations carried out at the mill involve the recovery of uranium, vanadium, and molybdenum (a contaminant in the uranium ore). Recovery and extraction operations for vanadium and uranium are housed in separate buildings. However, the two circuits are connected with the slime tailings effluent from the uranium circuit becoming the feed solution to the vanadium circuit after clarification in the mill ponds. Uranium ore is locally obtained from shaft and open-pit mines. A foreign source of ore is used as the dry feed to the vanadium circuit to supplement the soluble vanadium feed from the uranium circuit. During the July study, the average



LOCATION MAP
FIGURE 1



MINES DEVELOPMENT, INC.
URANIUM MILL
PROCESS PONDS AND TAILINGS PILES
FIGURE 2

ore feeds to the uranium and vanadium circuits were 400 and 15.5 tons/day, respectively. For uranium, this corresponded to operation at approximately sixty percent of plant capacity, 650 tons/day.

Pre-operational surveillance of the Cheyenne River was performed during February, 1956, by personnel of the South Dakota Department of Health and U. S. Public Health Service. Four stations were sampled: (1) upstream from the mill site at the State Highway 18 bridge, (2) approximately 1.5 miles downstream from Edgemont, (3) at Falls Canyon and (4) just upstream from the confluence with Tepee Creek. Unfortunately, since the mechanics of environmental surveillance were in the developmental stages at that time, radioactivity analysis was limited to gross procedures instead of the more definite analysis for specific radionuclides. Water samples contained 10 to 40 picocuries per liter (pCi/l) of dissolved alpha activity and 10 to 120 pCi/l of dissolved beta activity; suspended radioactivity was negligible. In retrospect, dissolved gross alpha and beta concentrations at the upper limits of the observed ranges now seem unusually high for natural background conditions. Bottom sediment samples showed an average content of 10 and 15 picocuries per gram (pCi/g) of dry solids of alpha and beta activity, respectively. All the biological samples (algae, insects, minnows and plankton) showed corresponding low concentrations of gross radioactivity. The initial post-operational monitoring effort (June 1957) did not show levels of dissolved radioactivity in either the Cheyenne River or Cottonwood Creek greater than background levels, despite a low flow drainage from the sand tailings pond to the creek containing 1400 and 1800 pCi/l of dissolved alpha and beta activity, respectively.

II. SUMMARY

Uranium and vanadium recovery operations carried out at the Edgemont mill generate liquid wastes and spent ore solids which are discharged to a system of ponds. These ponds retain the fine (slimes) and coarse (sand tailings) ore solids on the mill property. However, due to the permeability of the soil in which the ponds are excavated, liquid wastes are lost to the ground and eventually reach the Cheyenne River and Cottonwood Creek in the form of seepage. The impact of this seepage in the water environment is the following:

1. Unsightly discoloration of stream bank and channel areas by the accumulation and/or deposition of "iron-rich" solids.

   Although the areas so affected are rather extensive during low flow conditions, the only area which is readily visible from the State Highway 18 bridge is the seepage zone adjacent to Pond No. 2.

2. Increases chemical and radioactivity concentrations in Cottonwood Creek and, to a much lesser extent, the Cheyenne River.

   The 1964 study showed dissolved uranium and radium-

226 concentrations in Cottonwood Creek substantially in excess of background concentrations (30 and 100X greater, respectively). In subsequent studies, radium and uranium concentrations were lower; approximately one order of magnitude greater than background levels.

Consistent with the findings for Cottonwood Creek, the maximum radioactivity concentrations in the Cheyenne River were obtained in the 1964 study. At a location about 1.5 miles below the mill, dissolved radium-226 and uranium concentrations were 2.5 pCi/l and 130 μg/l, respectively. These values corresponded to a ten-fold increase above background. The results for other studies at this same sampling station and other downstream stations were substantially lower - values less than 1.0 pCi/l of radium-226 and 50 μg/l of uranium.

Flow data for the 1971 study indicated that Hat Creek has a decided impact on Cheyenne River water quality conditions, at least during low flow periods. During the 1971 study, Hat Creek was responsible for 80 percent of the Cheyenne River flow at the State Highway 71 bridge.

Increased radioactivity levels in the Cheyenne River downstream from the mill do not pose a health hazard from excessive exposure to radiation. Obviously, the non-use of the Cheyenne River for domestic water supply makes this conclusion a fact. However, a comparison of the observed concentrations of radium-226 and uranium with currently accepted standards (Table I) also shows that the radiological quality of the Cheyenne River is acceptable for drinking water purposes. Based on the radium-226 concentrations observed during low flow conditions, it seems possible that the annual average concentration of radium-226 does not exceed 1.0 pCi/l. If the Cheyenne River was used as a regular source of drinking water, the resultant intake would be only 5% of the transient rate of daily intake for the general population, as recommended by the Federal Radiation Council (upper limit of Range II). The fact that the maximum radium concentration observed in the Cheyenne River was less than the current Public Health Service guideline for radium-226 in drinking water also demonstrates the absence of a potential health hazard from this radionuclide. Similarly, the dissolved uranium concentrations in the river have not approached levels of public health significance. The maximum concentration

TABLE I RADIOACTIVITY STANDARDS

Radionuclide	Drinking Water Standard	Limiting Rate Of Daily Intake From All Sources (Annual Average)	Recommending Authority
Radium-226	3.0 pCi/1(a)	20 pCi/day	U.S. Public Health Service
		0 to 2 pCi/day-Range I(b) 2 to 20 pCi/day-Range II 20 to 200 pCi/day-Range III	Federal Radiation Council
Uranium	700 ug/1(c)	0.7 mg/day(d)	International Commission on Radiological Protection (ICRP)
	22 mg/1(c)	22 mg/day(d)	National Committee on Radiation Protection (NCRP)

(a) The limit may be exceeded if the radioactivity intake from all sources in addition to that from water does not exceed intake levels recommended by the Federal Radiation Council for control action (the upper limit of Range II).

(b) Action required:
Range I - Periodic confirmatory surveillance as necessary.
Range II - Quantitive surveillance and routine control.
Range III - Evaluation and application of conditional control measures as necessary.

(c) Calculated from the limiting rate of daily intake by assuming a daily intake from drinking water of 1 liter/day and no intake from other sources.

(d) Based on 1/30 of the maximum permissible concentration for natural uranium for continuous occupational exposure, the specific activity for uranium-238, an activity ratio (uranium-234/uranium-238) equal to unity, and a daily water intake of 2.2 liters/day from all sources.

of dissolved uranium observed in Cheyenne River was about 20% of the ICRP standard; negligible in comparison to the NCRP standard. (Note: To date, the more restrictive ICRP standard has not been formally adopted by the NCRP.)

The contaminated reach of Cottonwood Creek lies wholly within the mill property with access to the general public restricted. Therefore, the creek is not a direct source of radiation exposure to the general public.

Based on visual observations, sand tailings from the three storage areas (Pile No. 1, Pile No. 2, and Pond No. 2) are entering the water environment by wind and/or water errosion. Such off-site losses of these high-radioactivity solids is most undesirable and should be curtailed at an early date.

III. RECOMMENDATIONS

1. The bottom and sidewalls of the retention ponds should be sealed to eliminate seepage into Cottonwood Creek and the Cheyenne River.
2. A two phase program providing for the stabilization and ultimate disposal of sand tailings should be developed with a reasonable timetable for implementation. As a first phase, immediate action should be taken to stabilize the huge bulks of sand tailings stored in Pile No. 1, Pile No. 2, and Pond No. 2 against wind and/or water errosion. The most desirable alternative for the second phase of the program, ultimate disposal, seems to be storage in the excavated portions of the open-pit uranium mine operated by Mines Development, Inc.
3. Monitoring stations should be established on Cottonwood Creek (at the mouth) and the Cheyenne River (downstream from the mill) to determine the extremes in chemical and radioactivity concentrations as well as the annual average radioactivity concentrations. As a minimal effort, weekly grab samples should be collected with analyses performed on monthly composites. Monitoring should be continued

after recommendation (1), above, has been implemented to show the sustained integrity of the sealed ponds. During this stage, the frequency of sample collection could be reduced to monthly grabs.

4. The classification of Cottonwood Creek should be resolved in regard to applicable standards, i.e., effluent limits or receiving water standards. Upstream from the mill the creek is an intermittent stream whereas flow in the reach traversing mill property is maintained by seepage, possible spring flow, and drainage from an abandoned railroad well.

IV. WASTE MANAGEMENT PRACTICES

The waste management program conducted by Mines Development essentially provides for the on-site retention of liquid and solid wastes with no direct release to the water environment. Briefly, liquid wastes from the uranium and vanadium extraction circuits are discharged to a system of process ponds wherein volume reduction occurs by evaporation and seepage. Seepage losses are the result of pond excavation in a zone of permeable soil. In order to control the total volume of required ponding, water is recycled for use as process water. Sand tailings are stored in two unstabilized piles and two retention ponds. An areal schematic showing the locations of the ponds and the sand tailings piles is presented in Figure 2.

Operational functions of the various ponds are summarized in Table II. The flow scheme for the pond system is the following:

1. Slime tailings and sand tailings from the uranium circuit are discharged to Pond No. 7, a pond functioning as a retention and sedimentation basin.
2. Clarified vanadium-bearing liquor (blue liquor) is pumped to Pond No. 3.

TABLE II MILL PROCESS & RETENTION PONDS

Pond	Pond Use	
	Current	Past
No 1	Disposal of raffinate from the vanadium extraction circuit.	Retention of slime tailings from the uranium circuit.
No 2	Sand tailings storage.	Disposal of vanadium raffinate and retention of slime tailings.
No 3	Storage basin for vanadium-bearing liquor (blue liquor).	Retention of slime tailings.
No 4	Not in use.	"Polishing" sedimentation basin for vanadium-bearing liquor.
No 7	Retention and storage of slime tailings and sand tailings; sedimentation basin to produce clarified blue liquor.	Same as current use except for the storage of sand tailings.
No 8	Contingency.	
No 9	Not in use.	
No 10	Contingency.	

3. Clarified blue liquor is pumped from Pond No. 3 to the head-end of the vanadium extraction circuit.

4. Vanadium raffinate is discharged to Pond No. 1.

There is sufficient flexibility built into the pumping system to transfer liquid between any two ponds, including the two ponds which are in standby condition.

Until the weekend of August 27-28, 1966, Pond No. 2 was used for the storage and retention of slime tailings and vanadium raffinate. At that time, the discharge of repulped sand tailings was diverted from Pile No. 2 to this pond. This was an attempt to seal the bottom of Pond No. 2 with ore solids; thereby stopping the seepage into the Cheyenne River at the base of the bank. The resultant mass of sand tailings stored in this area rises above the original elevation of the pond surface. Based on visual observations, the tailings appear to be drifting toward Highway 18 and down the river bank with perhaps some level of entry into the Cheyenne River. This was anticipated when it was noted in the report on the 1966 study that "storage of sand tailings in Pond No. 2 does present this somewhat undesirable feature of placing the sand directly on the bank of the Cheyenne River."

Sand tailings Pile No. 1 is contiguous with Cottonwood Creek for a distance of several hundred feet (conservatively estimated). Therefore, there is undoubtedly some loss of solids to the creek as the result of errosion during a period of high runoff and wind transport. Although the bulk of sand tailings Pile No. 2 is located at much higher elevation than the channel of Cottonwood Creek, there appears to be sloughing of material from the pile onto the flood plain. In essence, sand tailings from the inactive piles are probably reaching the Cheyenne River with subsequent transport downstream into Angostura Reservoir.

V. PREVIOUS WATER QUALITY STUDIES

Short-term field studies to monitor water quality conditions in the Cheyenne River and Cottonwood Creek have been conducted on five occasions since the initial 1957 post-operational study: October 17-18, 1962; August 6-7, 1964; September 7-9, 1966; early December, 1967; August 15, 1968. These have been cooperative investigations between the South Dakota State Department of Health and the Environmental Protection Agency(a). For all studies, the radiochemical analyses were performed in EPA laboratories. In the case of 1966 study, water and bottom sediment sampling was a cooperative undertaking. State personnel were solely responsible for sample collection in the other studies. A list of the stations at which water and bottom sediment samples have been collected in the course of these studies is given in Table III.

The results of the physical and chemical analyses of water samples are summarized in Tables IV and V. Similar data for the seepage samples collected during the 1966 study are pre-

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(a) Organizational predecessors of the Office of Water Programs, Environmental Protection Agency. That is, the U.S. Public Health Service (Division of Water Supply and Pollution Control), the Federal Water Pollution Control Administration and the Federal Water Quality Administration.

TABLE III CHEYENNE RIVER AND COTTONWOOD CREEK SAMPLING STATIONS

Station	Description
1	Cheyenne River just upstream from the Highway 18 bridge outside of Edgemont.
2	Cottonwood Creek at the pedestrian bridge; 200 feet above sand tailings Pile No. 1 and just south of the fence that forms the south boundry of mill property.
3	Cottonwood Creek several hundred feet upstream from its confluence with the Cheyenne River; downstream from sand tailings Pile No. 2.
4	Cheyenne River between the Cottonwood Creek confluence and Pond No. 1.
5	Cheyenne River about 1.5 miles downstream from the mill.
6	Cheyenne River at the Highway 71 bridge.
7	Cheyenne River in the headwaters of Angostura Reservoir; 0.5 miles downstream in Tepee Canyon.
8	Central portion of Angostura Reservoir.
9	Cheyenne River about 0.25 miles below Angostura Dam.

TABLE IV DISSOLVED RADIOACTIVITY IN CHEYENNE RIVER AND COTTONWOOD CREEK WATER SAMPLES

Station	Dissolved Radioactivity Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Radium-226 (pCi/l)	Lead-210 (pCi/l)	Uranium (µg/l)	Thorium (µg/l)
1 - 1962	12	55	----	---	--	----
1964	--	--	0.26	---	17	----
1966	15	61	0.25	0.6	12	----
1967	--	--	0.10	0.9	13	N.D.
1968	--	--	0.10	---	7	N.D.
2 - 1962	9	--	----	---	--	----
1964	--	--	0.26	---	7	----
1966	17	163	0.10	0.7	18	----
1967	--	--	----	---	--	----
1968	--	--	0.11	---	18	N.D.
Cottonwood Creek at the seepage zone adjacent to Pond No. 7 (1968)	--	--	0.86	---	100-200 (a)	----

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(a) Analytical difficulty prevented reporting of a specific concentration.
N.D. - Not detectable, i.e. net counting rate less than two standard deviations counting rate

TABLE IV (Continued) DISSOLVED RADIOACTIVITY IN CHEYENNE RIVER AND COTTONWOOD CREEK WATER SAMPLES

Station	Dissolved Radioactivity					
	Gross Alpha (pCi/1)	Gross Beta (pCi/1)	Radium-226 (pCi/1)	Lead-210 (pCi/1)	Uranium (µg/1)	Thorium (µg/1)
Cottonwood Creek at the seepage zone adjacent to sand tailings Pile No. 2 (1967)	--	--	0.60	N.D.	53	2.3
3 - 1962	48	180	----	---	--	----
1964	--	--	24	---	550	----
1966	1	53	1.6	1.2	49	----
1967	--	--	0.60	N.D.	64	5.7
1968	--	--	0.46	---	12	5.0
Cheyenne River adjacent to Pond No. 2 seepage zone						
1964	--	--	0.26	---	4	----
1966	14	--	0.50	4.7	18	----
1967	--	--	0.10	0.2	26	----
1968	--	--	0.27	---	15	----

TABLE IV (Continued) DISSOLVED RADIOACTIVITY IN CHEYENNE RIVER AND COTTONWOOD CREEK WATER SAMPLES

Station	Dissolved Radioactivity Gross Alpha (pCi/l)	Gross Beta (pCi/l)	Radium-226 (pCi/l)	Lead-210 (pCi/l)	Uranium (µg/l)	Thorium (µg/l)
4 - 1966	15	50	0.29	---	--	----
1967	--	--	----	---	--	----
1968	--	--	0.44	---	10	N.D.
5 - 1962	11	56	----	---	--	----
1964	--	--	2.5	---	130	----
1966	9	127	0.50	0.2	26	----
6 - 1962	20	--	----	---	--	----
1964	--	--	0.44	---	8	----
1966	5	101	0.30	N.D.	13	----
1967	--	--	0.40	N.D.	19	8.5
7 - 1962	3	37	----	---	--	----
1966	5	51	0.26	0.1	9	----
8 - 1966	5	23	0.14	---	--	----
9 - 1966	3	29	0.28	0.1	13	----

TABLE V CHEMICAL AND PHYSICAL CHARACTERISTICS OF CHEYENNE RIVER AND COTTONWOOD CREEK WATER SAMPLES

Station	Dissolved Solids (mg/1)	Susp. Solids (mg/1)	Total Iron (mg/1)	Sulfates (mg/1)	Nitrates (mg/1)	pH	Vanadium (µg/1)
1 - 1962	3552	--	--	----	----	--	---
1964	----	--	36	2140	0	7.8 - 8.0	---
1966	3098	28	--	----	----	--	---
1967	----	--	--	----	----	--	<100
1968	----	--	--	----	----	--	<20
2 - 1962	4160	--	--	----	----	--	---
1964	----	--	20	2350	0	7.0	---
1966	4112	39	--	----	----	7.3	---
1967	----	--	--	----	----	--	---
1968	----	--	--	----	----	--	<20
Cottonwood Creek at the seepage zone adjacent to Pond No. 7 (1968)	----	--	--	----	----	--	<20

TABLE V (Contined) CHEMICAL AND PHYSICAL CHARACTERISTICS OF CHEYENNE RIVER AND COTTONWOOD CREEK WATER SAMPLES

Station	Dissolved Solids (mg/l)	Susp. Solids (mg/l)	Total Iron (mg/l)	Sulfates (mg/l)	Nitrates (mg/l)	pH	Vanadium (µg/l)
Cottonwood Creek at the seepage zone adjacent to sand tailings Pile No. 2 (1967)	----	--	--	----	----	--	<100
3 - 1962	5328	--	--	----	----	--	---
1964	----	--	67	2400	0.29	6.4	---
1966	6286	268	--	----	----	6.3	---
1967	----	--	--	----	----	--	<100
1968	----	--	--	----	----	--	<20
Cheyenne River adjacent to Pond No. 2 seepage zone							
1964	----	--	196	3240	0.36	6.0	---
1966	19500	178	--	----	----	6.5	---
1967	----	--	--	----	----	--	<100
1968	----	--	--	----	----	--	<20

TABLE V (Continued) **CHEMICAL AND PHYSICAL CHARACTERISTICS OF CHEYENNE RIVER AND COTTONWOOD CREEK WATER SAMPLES**

Station	Dissolved Solids (mg/l)	Susp. Solids (mg/l)	Total Iron (mg/l)	Sulfates (mg/l)	Nitrates (mg/l)	pH	Vanadium (μg/l)
4 - 1966	3556	21	--	----	----	--	---
1967	----	--	--	----	----	--	---
1968	----	--	--	----	----	--	<20
5 - 1962	3624	--	--	----	----	--	---
1964	----	--	42	3667	1.52	7.4	---
1966	3538	6	--	----	----	--	---
6 - 1962	3084	--	--	----	----	--	---
1964	----	--	47	1593	0.10	7.8	---
1966	3664	5	--	----	----	--	---
1967	----	--	--	----	----	--	<100
7 - 1962	824	--	--	----	----	--	---
1966	1558	37	--	----	----	--	---
8 - 1966	1656	2	--	----	----	--	---
9 - 1966	1668	3	--	----	----	--	---

sented in Table VI. Although data for the 1962, 1964, and 1966 studies were the subject of a previous report, these data are included herein to maintain continuity and to present the complete historical record, particularly for comparative purposes.

As shown in Table IV seepage into Cottonwood Creek results in significant degradation of water quality. The specific reductions in chemical, physical and radiological quality were the following:

1. Significant increases in the concentration of dissolved gross alpha and beta radioactivity, radium-226, uranium, and lead-210. The maximum concentrations of radium-226 and uranium were observed in 1964. These values, 550 µg/l of uranium and 24 pCi/l of radium-226 were approximately 30 and 100 times the respective background levels.
2. Increases in the dissolved solids and total iron (dissolved) concentrations.
3. pH decrease.
4. Discoloration to the extent that the creek has been described as "running red" on occasion. This was considered to be attributable to a chemical reaction between the natural water and the iron-bearing seepage.

TABLE VI **PHYSICAL AND RADIOLOGICAL CHARACTERISTICS OF SEEPAGE SAMPLES**

	Dissolved Radioactivity						
Description	Gross Alpha (pCi/1)	Gross Beta (pCi/1)	Radium-226 (pCi/1)	Lead-210 (pCi/1)	Uranium (µg/1)	Dissolved Solids (mg/1)	pH
Seepage from bank of Cottonwood Creek adjacent to Sand Tailings Pile No. 2	148	187	32	0.8	175	8212	6.3 to 6.7
Seepage from bank of Cheyenne River upstream from Pond No. 1	35	342	1.4	0.4	89	21,800	5.7

> Presumably, iron-bearing precipitate was formed which gave the stream a red to reddish-brown appearance when suspended and transported in the liquid phase.

Although the flow in Cottonwood Creek is intermittent in nature upstream from the mill, seepage or a combination of seepage and spring flow apparently maintain flow in the creek throughout the reach on mill property. Intermittent flow appears to be the reason for the finding of maximum concentrations during the 1964 study. There was no observable flow upstream from the seepage zone in 1964 - the only study period for which such a condition was noted. Correspondingly, the differences in concentration increases indicated by the five studies are considered to be more a function of specific flow conditions and the dilution provided rather than differences in seepage flow or quality.

Several factors indicated the process and retention ponds were a major source of the seepage entering Cottonwood Creek: the extension of the zone of active seepage to bank height(s) substantially above the water surface, accumulation of reddish-brown deposits in the seepage zone considered to be indicative of high iron content in the seepage, and the physical and radiological characteristics of the seepage samples. The high radium-226 and uranium concentrations (Table VI) low pH, and implied high iron content of the seepage samples were consistent with the physical and chemical composition of the vanadium raffinate and vanadium-bearing liquors held in the ponds. These ponded liquors were characterized by low pH values (2.0 to 2.5), dissolved radium-226 concentrations in the range of 60 to 300 pCi/l, and dissolved iron concentrations in excess of 500 mg/l.

Another possible source of seepage in 1966 was drainage from sand tailings Pile No. 2 since the pumping of repulped tailings (50% slurry) was terminated only two weeks before the study. Moreover, mill personnel believed that as far as bulk flow into the creek was concerned, an underground spring rather than pond seepage or tailings pile drainage was the causative agent. If an underground spring is responsible for sustained flow in the creek, the water quality conditions in the creek indicate that the spring flow is contaminated by pond seepage.

The adverse effect of seepage from Pond No. 2 into the Cheyenne River was the unsightly discoloration of the stream bed at the base of the bank and for some distance downstream. Although the 1966 water samples from this location showed increased radioactivity levels (Table IV), the results were judged to be representative of partially diluted seepage percolating up through the stream bed; not stream quality. These samples were collected from a channel of flowing water adjacent to the dike, but separated from the main channel by a sand bar. As such, the indicated change in radiological water quality represented only a minute fraction of the Cheyenne River flow at this site.

Seepage into the Cheyenne River at a point just upstream from Pond No. 1 contained concentrations of dissolved radium and uranium in excess of surface water background levels (Table VI). However, the concentrations were much lower than those found in the seepage flowing into Cottonwood Creek - an order of magnitude less for radium-226. The seepage had no effect on Cheyenne River water quality because the observed flow was only trickle.

Downstream from the confluence with Cottonwood Creek, the Cheyenne River showed recovery to nominal or background levels in the vicinity of Station 5 or 6. Consistent with the findings for Cottonwood Creek, the maximum results for dissolved radium-226 and uranium concentrations in the Cheyenne River were observed in the 1964 study - 2.5 pCi/l of radium-226 and 130 μg/l of uranium. This is in contrast to the results of the other studies which have shown radium-226 and uranium concentrations in the river to be only slightly in excess of background levels. For example, with exception of the 2.5 pCi/l result, the maximum radium-226 concentration was 0.5 pCi/l at Station 5 during the 1966 study.

Chemical and radioactivity results for bottom sediment samples are presented in Table VII. Although the vanadium results indicated somewhat higher levels in the seepage zone of Cottonwood Creek, the finding was not considered definitive in terms of providing positive identification of vanadium liquors as a major source of seepage. This was due to the limited number of samples analyzed and the relative insensitivity of the analytical procedure. Similarly, the iron data did not provide a quantitive-type illustration of the bank and channel discoloration. This was, in part, attributable to the method of sample collection. Sediment samples were collected in a manner such that they were representative of the average condition at each location and were not limited to the collection of obviously discolored material (unless the discoloration was distributed across the channel width).

Radium-226 and uranium concentrations in the bottom sediments showed the same contamination pattern as that exhibited by the corresponding results for water samples. That is, the

TABLE VII RADIOACTIVITY CHEMICAL CONTENTS OF BOTTOM SEDIMENTS FROM THE CHEYENNE RIVER AND COTTONWOOD CREEK

Station	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Radium-226 (pCi/g)	Uranium (µg/g)	Vanadium (µg/g)	Iron (µg/g)
1 - 1962	7	37	---	---	---	----
1964	--	--	1.4	2.4	---	----
1966	5	18	1.2	---	---	----
1967	--	--	---	---	---	----
1968	--	--	1.2	0.6	<50	4720
2 - 1962	70	195	---	---	---	----
1964	--	--	4.4	5.6	---	----
1966	7	41	2.0	---	<50	>2500
1967	--	--	---	---	---	----
1968	--	--	2.3	2.2	60	8180
Cottonwood Creek at the seepage zone adjacent to Pond No. 7 (1968)	--	--	7.9	2.7	<50	9530

TABLE VII (Continued) RADIOACTIVITY CHEMICAL CONTENTS OF BOTTOM SEDIMENT FROM THE CHEYENNE RIVER AND COTTONWOOD CREEK

Station	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Radium-226 (pCi/g)	Uranium (µg/g)	Vanadium (µg/g)	Iron (µg/g)
Cottonwood Creek at the seepage zone adjacent to sand tailings Pile No. 2						
1966	55	61	12	---	---	----
1967	--	--	15	9.5	310	>2500
3 - 1962	124	195	--	---	---	----
1964	--	--	74	62	---	----
1966	55	61	12	---	---	----
1967	--	--	45	6.5	190	>2500
1968	--	--	31	8.5	90	6350
Cheyenne River at base of Pond No. 2 dike						
1964	--	--	1.1	9.3	---	----
1966	4	24	1.0	---	<50	1550
1967	--	--	1.8	1.9	<50	>2500
1968	--	--	1.1	0.6	<50	1890

TABLE VII (Continued) **RADIOACTIVITY CHEMICAL CONTENTS OF BOTTOM SEDIMENTS FROM THE CHEYENNE RIVER AND COTTONWOOD CREEK**

Station	Gross Alpha (pCi/g)	Gross Beta (pCi/g)	Radium-226 (pCi/g)	Uranium (µg/g)	Vanadium (µg/g)	Iron (µg/g)
4 - 1966	11	33	2.9	---	<50	1875
1967	--	--	3.7	2.2	<50	1970
1968	--	--	2.7	1.6	60	3010
5 - 1962	14	64	---	---	--	----
1964	--	--	3.9	11	--	----
1966	15	25	2.7	---	--	----
1968	--	--	2.1	1.5	<50	3150
6 - 1962	13	91	---	---	--	----
1964	--	--	0.9	1.4	--	----
1966	7	24	1.7	---	<50	1075
1967	--	--	0.9	0.9	<50	825
7 - 1962	11	47	---	---	--	----
1966	8	31	1.7	---	--	----
8 - 1966	6	32	1.5	---	--	----
9 - 1966	4	17	1.3	---	--	----

highest level of contamination occurred in Cottonwood Creek with concentrations ranging from 12 to 74 pCi/gram for radium-226 and 7 to 85 μg/gram for uranium (Table VII -Station 3). These values are in comparison to background concentrations on the order of 1.0 to 2.0 pCi of radium-226 and 1.0 to 2.0 μg of uranium. In the Cheyenne River, the sediment concentrations decreased to background levels in the reach between Stations 5 and 6. Radium-226 and uranium concentrations at the pedestrian bridge across Cottonwood Creek (Station 2) were slightly greater than background levels. A possible explanation is periodic contamination of this location by windblown sand tailings from Pile No. 1 (located several hundred feet downstream).

Radium-226 results for fish collected from Angostura Reservoir during the September, 1966, study are shown in Table VIII. Based on a comparison with similar results for fish collected at locations upstream from uranium mills in the Colorado River Basin, the Angostura fish were at typical background levels. This was consistent with the background level of dissolved radium-226 in Angostura Reservoir.

TABLE VIII RADIUM-226 CONCENTRATIONS IN ANGOSTURA RESERVOIR FISH
SEPTEMBER, 1966

	Radium-226 in Flesh			Radium-226 in Bone
Species[(a)]	Live Weight of Composite Sample (gram)	pCi/gram Ash Weight	pCi/kilogram Wet Weight	pCi/gram Ash Weight
Black Crappie (3)	105	0.06	0.75	0.08
Bluegill (6)	151	0.04	0.52	0.07
Ringed Perch (48)	727	0.47[(b)]	5.3[(b)]	0.10

(a) Number in parentheses refers to the number of fish in the composite sample

(b) Probably high as the result of the fusion of the sample with the porcelain dish during dry ashing.

VI 1971 FIELD STUDY

The July 1971 field study was conducted by personnel of the Environmental Protection Agency (Radiological Activities Section, Office of Water Programs) in cooperation with the South Dakota State Department of Health. Sampling extended over the five day period of July 26-30.

STUDY PROCEDURES

Sampling stations on the Cheyenne River and three tributaries, Cottonwood Creek, Hat Creek, and Cascade Springs, are listed in Table IX. Water samples were collected daily at the Cheyenne River and Cottonwood Creek stations (excluding Stations 9 and 10) whereas single grab samples were collected from Hat Creek and Cascade Springs. Bottom sediment samples were collected once at each station during the study period.

Staff gages (rated with a pygmy current meter) were used to meter the flow in Cottonwood Creek at each of the three sampling stations. The permanent gaging stations of the U. S. Geological Survey were used to obtain the flows in the Cheyenne River above the Edgemont mill and downstream at the State Highway 71 bridge. Flow in Hat Creek was also obtained from a U.S.G.S. gaging station.

TABLE IX COTTONWOOD CREEK AND CHEYENNE RIVER SAMPLING STATIONS - 1971

Station	Description
1	Cheyenne River just upstream from the State Highway 18 bridge outside of Edgemont; at the railroad bridge.
2	Cottonwood Creek upstream from mill property at the county road bridge; off State Highway 52.
3	Cottonwood Creek at the road culvert; downstream from sand tailings Pile No. 2.
4	Cottonwood Creek at confluence with the Cheyenne River.
5	Cheyenne River about 1.5 miles downstream from the mill.
6	Cheyenne River about 6 miles downstream from the mill; at Gull Hill Park.
7	Cheyenne River at ford on County Road 11.
8	Cheyenne River at State Highway 71 bridge.
9	Cheyenne River in the headwaters of Angostura Reservoir.
10	Cheyenne River below Angostura Dam.
11	Hat Creek.
12	Cascade Springs.

In addition to the collection of samples at the main stations on Cottonwood Creek and the Cheyenne River, bottom sediment samples were also collected in the following areas:

(a) Cottonwood Creek:

Six locations between the pipeline suspension bridge immediately upstream from sand tailings Pile No. 2 and the pedestrian footbridge. Sampling locations were selected to assess the variations in radioactivity concentrations throughout this previously unsampled reach.

(b) Cheyenne River:

Along the edge of the river channel extending from the downstream edge of Pond No. 1 for a distance of approximately one mile downstream (seven samples). This area was characterized by reddish-brown discoloration.

Thirteen soil samples were collected from the bank and dry stream bed adjacent to Pond No. 2.

Seepage samples were collected at four locations by excavating small collection basins in the bank proper:

(1) Cottonwood Creek just upstream from the pipeline suspension bridge (at the bank-stream bed interface).

(2) Cottonwood Creek several hundred yards upstream from the pipeline suspension bridge (approximately six feet above the water level in the creek).

(3) Cheyenne River just upstream from Pond No. 1 (approximately two feet above the stream water level).

(4) Cheyenne River about 1 1/2 miles downstream from the mill (just above the stream water level).

The collection basins were allowed to flush overnight and the samples collected the following morning with a polyethlene beaker or glass pipette. At the base of the Cheyenne River bank adjacent to Pond No. 2, seepage was collected from a natural depression in the dry steam bed.

Water and bottom sediment samples were collected from Angostura Reservoir at thirteen locations, providing complete coverage of the impoundment. At each station, the water column was sampled at the surface and near the bottom. Fish samples for radiological analysis were obtained from the fish sampling study conducted earlier in the year by the Division of Field Investigations - Denver, Environmental Protection Agency.

To assess the chemical and radiological characteristics of ground water in the mill environs, grab samples of well water were collected from the Edgemont reservoir well, Edgemont park well, Edgemont airport well, Mines Development process water well, an abandoned railroad well (next to Pond No. 2), and the Cheyenne River campground well (across the river from the mill).

SAMPLE PROCESSING PROCEDURES

Surface water samples and seepage samples were filtered on the day of collection. Well water samples were not filtered. All pH measurements were performed in the field or in the mill laboratory (within a few hours of collection) with a Yellow Springs portable meter.

Chemical and radiochemical analyses will be performed on the daily water samples collected at the Cottonwood Creek and Cheyenne River stations as well as 5-day composite samples. In the case of seepage in the vicinity of Pond No. 1, analyses will be performed on a composite sample prepared from the samples collected on two consecutive days.

Due to the large number of samples requiring analysis, the time required for a radium-226 determination, and the complexities of preparing sediment samples for radiochemical analysis, the quantitive data to be reported herein are largely limited to pH, dissolved uranium, and total alpha radium (dissolved) for water samples. A complete compilation of the radioactivity results will be the subject of a supplemental report.

Spectrographic metals analysis of the seepage samples was performed by the EPA Analytical Quality Control Laboratory, Cincinnati, Ohio.

RESULTS

Flows in Cottonwood Creek during the study period averaged 0.1 cfs at the upstream stations, 0.4 cfs at the road culvert, and 0.5 cfs at the mouth. The small increase between the culvert and the mouth might represent the drainage into the creek from the abandoned railroad well. However, the small difference is within the limits of metering error. Flow in the Cheyenne River was about 5 cfs at the upstream railroad bridge and approximately 132 cfs at the State Highway 71 bridge. The increase was largely attributable to Hat Creek (100 cfs) and Cascade Springs. All other tributaries were dry.

The limited results on water quality conditions in Cottonwood Creek and the Cheyenne River are presented in Table X. These data show the same pattern of water quality degradation as observed in past studies. That is, due to seepage, the dissolved uranium concentration in Cottonwood Creek approached a level in excess of 10X the natural level. In contrast, there

TABLE X DISSOLVED RADIOACTIVITY IN THE CHEYENNE RIVER, COTTONWOOD CREEK, HAT CREEK, AND CASCADE SPRINGS

	Dissolved Radioactivity[a]			
Station	Total Alpha Radium (pCi/l)	Uranium (µg/l)	Thorium (µg/l)	pH
1	0.11	16	4	8.0 - 8.2
2	0.67	26	3	7.0 - 7.1
3	0.75	147	2	6.4 - 6.8
4	0.09	177	1	6.7 - 7.1
5	0.17	28	7	7.8 - 8.0
6	0.32	14	5	8.1 - 8.4
7	0.11	19	3	7.9 - 8.2
8	0.10	14	3	7.9 - 8.2
9	0.14	10	3	-----
10	0.11	12	-	-----
11	0.08	24	2	7.7
12	0.08	5	-	6.8

(a) With the exception of single grab samples for Stations 11 and 12, the values refer to 5-day composite samples.

was a negligible concentration increase in the Cheyenne River downstream from the mill. This finding is consistent with the flow data which showed the dilution capacity afforded by the Cheyenne River was on the order of 50 times.

The total alpha radium analysis is commonly used as a quick guide to the probable radium-226 concentration. However, the analysis is not particularly sensitive and should not be depended upon completely to demonstrate small differences. For example, the results for the total alpha concentrations in the Cottonwood Creek samples indicated essentially no increase in the dissolved radium-226 concentration in the reach receiving seepage, a finding which was not consistent with the uranium results. However, radium-226 determinations on the composite samples for Stations 2 and 3 showed dissolved concentrations of 0.26 and 3.1 pCi/l, respectively. This was in complete accord with the uranium results.

By visually inspecting the reach of Cottonwood Creek extending from the pipeline bridge to the pedestrian bridge, the occurence of seepage from mill ponds was observed to extend at least as far upstream as a point opposite the north edge of Pond No. 7. In this area, the high bank was observed to be moist (and "dripping") to heights of over six feet above the water surface. Further, pooled sections of the creek were observed to have the same yellowish-green color as the seepage samples. Quantitative support for the conclusion that the mill ponds were a significant source of seepage was the high concentrations of molybdenum (5 to 25 mg/l) in the seepage samples. Molybdenum is a mill byproduct and dissolved concentrations in the ponds ranged from 20 to 75 mg/l[a]. The seepage samples also showed traces of iron and manganese (<2 mg/l) and, in one case, chromium, nickel and lead concentrations in the range of 5 to 25 mg/l.

Areas of reddish-brown (reddish-orange) channel discoloration were observed in Cottonwood Creek as far upstream as the pedestrian bridge and on both sides of the channel. This suggested the possibility that natural sources (springs, etc.) were partly responsible for the channel discoloration effect. However, the magnitude of discoloration within the mill proper indicates that seepage intensifies the problem and the overall situation is undoubtedly much worse than it would be in the absence of seepage from the ponds.

Based on the discoloration of the dry stream channel adjacent to Pond No. 2, seepage from the pond has not been com-

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(a) Analysis of samples collected from the ponds.

pletely stopped despite the fact that the pond is an inactive repository for uranium sand tailings. The pond was not completely dry but contained a small pool of water in the end nearest the mill. Presumably, drainage from the abandoned railroad well is entering the pond.

The impact of seepage in the area of Pond No. 1 was substantially greater than that observed in 1966. During the 1966 study, the seepage caused only a small localized effect. However, in this most recent study, the impact of the seepage as measured by channel discoloration was observed for a distance of over one mile downstream. It was not determined whether this was the result of differences in Cheyenne River flow or increased seepage flow.

Dissolved uranium concentrations in the Angostura Reservoir samples were at natural background levels. The overall concentration range was 6 to 13 ug/l with no significant differences between the surface and "bottom" samples.

ADDENDUM

DISSOLVED MERCURY IN CHEYENNE RIVER, COTTONWOOD CREEK, AND SEEPAGE SAMPLES

Station	Dissolved Hg (ug/l)
1. Cheyenne River just upstream from the State Highway 18 bridge outside of Edgemont.	2.1
2. Cottonwood Creek upstream from mill property at the county road bridge; off State Highway 52.	3.5
3. Cottonwood Creek at the road culvert; downstream from sand tailings Pile No. 2.	4.2
4. Cottonwood Creek at confluence with the Cheyenne River.	1.8
5. Cheyenne River about 1.5 miles downstream from the mill.	0.6
6. Cheyenne River about 6 miles downstream from the mill; at Gull Hill Park.	3.0
7. Cheyenne River at ford on County Road II.	3.2
8. Cheyenne River at State Highway 71 bridge.	0.8
9. Cheyenne River in the headwaters of Angostura Reservoir.	1.8
Seepage into Cottonwood Creek just upstream from the pipeline suspension bridge.	1.0
Seepage into Cottonwood Creek several hundred yards upstream from the pipeline suspension bridge.	2.3
Seepage into the Cheyenne River just upstream from Pond No. 1.	2.2

DR. LAMMERING: The statement which I will give is generally a summary and paraphrasing of the report. I will be reading this and I will also make it available to the recorder when I get finished.

In this presentation we will address ourselves to a discussion of the impact of the Mines Development, Inc., uranium mill on water quality conditions in the Cheyenne River. To orient ourselves geographically, the uranium mill is located on the south side of the Cheyenne River just outside the town of Edgemont. Cottonwood Creek, an intermittent stream, passes through mill property. Angostura Reservoir, a recreational lake, lies about 35 miles downstream of the mill just outside the town of Hot Springs.

Unlike the preceding presentations which have focused on mercury pollution of the Cheyenne system, our primary concern with the Edgemont mill is the radiological pollution which results from mineral recovery operations.

The potential sources of radioactivity releases to the Cottonwood Creek-Cheyenne River System involve both liquid and solids wastes. This includes slime tailings liquor and sand tailings from the uranium extraction circuit and raffinate from the vanadium extraction circuit. I might point out here that the mill is involved both in the recovery of vanadium as well as uranium. We performed a study in July of this year and at that time the vanadium ore processing rate was about 15 tons per day whereas uranium was being processed at the rate of about 400 tons per day.

The radioactivity we are concerned with is of natural origin with uranium, radium-226 and lead-210 the radionuclides of prominent importance from the standpoint of human exposure.

Now, we are considering only the water environment. If we are going to consider air pollution we would have to add to this list of critical radionuclides radon-222, which is a daughter product of radium-226. This gaseous daughter would be emitted from the sand tailings pile which is stored on the mill site.

A word on waste management practices. Waste management practices carried out at the Edgemont mill do not involve the direct discharge of liquid radioactive wastes to the surface waters, and I would like to emphasize they do not involve this. Liquid wastes are discharged to a system of on-site ponds. However, these ponds are not impervious and waste liquors are being lost to the ground and ultimately enter Cottonwood Creek and the Cheyenne River system as seepage.

If you would, I would like you to refer to the report and Figure No. 2. There are three seepage zones. On Cottonwood

Creek the seepage zone extends to the east of Cottonwood Creek and it extends from sands tailings pile No. 2 upstream to a point, oh, approximately adjacent to pond No. 7 and this was determined by walking the creek.

A second seepage zone is into the Cheyenne River and this occurs at pond No. 2, which is just to the east of the U.S. Highway 18 bridge.

The third seepage zone is just upstream from pond No. 1 and that would be downstream from Cottonwood Creek.

Since 1956 mill operations have resulted in accumulation of over 1 million tons of sand tailings. The sand tailings are stored in three areas.

Again if you would please refer to Figure No. 2, you can see two tailings piles. These are located on adjacent sides of Cottonwood Creek. The third area of sand tailings storage is pond No. 2. Now, until 1966 this pond was used as a retention pond for vanadium raffinate liquor. On September 16 of 1966 sand tailings were started to be pumped to pond No. 2 in an effort to curtail seepage into the Cheyenne River. This is now an inactive zone storage and the tailings are no longer being pumped to pond No. 2. However, the net result has been a mounding of sand tailings to a height of several feet above the original elevation of the pond. Currently sand tailings are being pumped with slime tailings liquors to Pond No. 7.

Measures to stabilize the sand tailings masses against wind and water erosion are apparently not practiced.

The Radiological Activities Section--and I would like to make a note here. When I refer to the Radiological Activities Section I am referring to the Cincinnati based group under the Office of Water Programs EPA, but actually the studies with the State of South Dakota have gone back many years, and so it is really the Radiological Activities Section and all other organizational predecessors of this group, which goes back through FWPCA, FWQA and on into the Public Health Service, Division of Water Supply and Pollution Control.

This section has cooperated with the State of South Dakota Department of Health in the conduct of field studies aimed at quantitatively defining the impact of mill operations on conditions in Cottonwood Creek and the Cheyenne River. Short-term studies of one to two days duration were conducted in June of 1957, October of 1962, August 1964, September of 1966, December of 1967, and August of 1968.

In all of these studies, grab water and bottom sediment samples were collected from Cottonwood Creek and the Cheyenne River. They were at upstream locations and downstream locations.

In the case of the Cheyenne River, it continued on down to the Angostura Reservoir.

The scope of the 1966 study was expanded to include the collection of water in bottom sediment samples from one location in Angostura Reservoir together with a fish composite sample. We also collected seepage samples on the mill proper.

The role of EPA and predecessor organizations in these short-term studies involved the radiochemical analysis of all samples and in 1966 cooperation in the field collection of samples.

To fill the informational gaps which resulted from the short-term studies, the Radiological Activities Section, again at the request of the State, conducted an intensive water quality study during the period of July 26 through 30 of this year. In addition to determining water quality conditions during the period of dry weather flow, the study objectives were to determine and evaluate:

1. Chemical and radioactivity loadings on Cottonwood Creek and the Cheyenne River as the result of seepage from mill ponds; and

2. Radioactivity levels in the water, biota and bottom sediment of Angostura Reservoir.

I would just like to comment a little bit on the intensiveness of the study procedures.

We conducted flow measurements on Cottonwood Creek and on the Cheyenne River. In the case of Cottonwood Creek the flow measurements were made upstream at a county road bridge, downstream from a point of seepage, at a road culvert on mill property, and at the confluence of Cottonwood Creek with the Cheyenne River. Flows on Cheyenne River were determined from the permanent USGS gauging stations located on Highway 18 bridge upstream from the mill and the Highway 71 bridge, which is quite a distance downstream. I am sorry, but I don't have the exact mileage down to the station. We also obtained flows from the USGS station on Hat Creek.

And I might point out here that actually the bulk of flow which we observed was from Hat Creek.

At Edgemont Cheyenne River flow was 5 cfs. Hat Creek contributed 100 cfs or 132 cfs, I am sorry, and then downstream at the Highway 71 bridge Cheyenne River flow was essentially the 130 cfs contributed by Hat Creek.

In terms of water samples, we sampled Cottonwood Creek at three stations. These stations were sampled daily over a 5-day period and composites made.

The Cheyenne River, we sampled seven stations. Five were sampled daily with composite samples prepared.

Dr. M. W. Lammering

Sediment samples. We collected a sufficient number of sediment samples, in my opinion, to show radioactivity profiles on Cottonwood Creek from the upstream county road bridge down to the confluence. In the case of the Cheyenne River, sediment samples were collected from the Highway 18 bridge down to Angostura Reservoir.

Seepage samples. Samples were collected of seepage into Cottonwood Creek and into the Cheyenne River downstream from the confluence of Cottonwood Creek. These were the three zones of seepage which I mentioned previously.

In the case of Angostura Reservoir we collected water samples at 13 locations and in each case we sampled the vertical water column. Water samples were collected at the surface and near the bottom. Bottom sediment samples were collected at each of the 13 water sampling stations. In the case of fish, the fish samples collected for radioactivity analysis were taken from those collected by the Denver Field Investigation Center for mercury analysis.

Total alpha radium, radium-226, uranium and thorium analyses will be conducted on all samples. Additionally, seepage samples and selected water and bottom sediment samples will be analyzed by spectrographic techniques to determine metals concentrations.

Dr. M. W. Lammering

I am using future tense here because unfortunately these analyses have not been completed to date. We have only processed the samples for uranium.

Dissolved mercury analyses were conducted on the composite water samples from Cottonwood Creek and the Cheyenne River as well as two seepage samples.

The findings of the short-term studies and those obtained to date for the comprehensive 1971 study are presented in the conference report which you have in your possession, the blue copy.

To briefly summarize the data accumulated to date, the physical, chemical and radiological analyses of seepage samples indicate that the mill ponds are a source of seepage to the Cheyenne River and Cottonwood Creek. Further, the seepage has a twofold effect or impact on the water environment.

First, the seepage causes an unsightly discoloration of stream bank and channel areas by the accumulation and/or deposition of iron-rich solids.

Second, the radioactivity-bearing seepage increases dissolved radioactivity concentrations in Cottonwood Creek and to a much lesser extent those in the Cheyenne River.

As far as the Cheyenne River is concerned, the areas of discoloration occur in the channel adjacent to Pond No. 2, and I refer you to Figure 2 of the report, and downstream from Pond No. 1. Although seepage into the river in the vicinity of Pond No. 1 has the more pronounced effect, only the aesthetic pollution associated with seepage from Pond No. 2 is visible from the State Highway 18 bridge.

The effect of seepage on dissolved radioactivity concentrations in Cottonwood Creek is largely a function of dilution available from upstream flow. At times this dilution capacity is zero. I mentioned that the stream was intermittent in nature.

The maximum radioactivity concentrations that we have observed in Cottonwood Creek samples occurred during 1964 and in this case there was no flow upstream from the mill. We observed 24 picocuries per liter of dissolved radium-226 and 550 micrograms per liter of dissolved uranium. These could be compared in this reach of the creek to the normal background values of 0.1 to 0.3 pCi/l of dissolved radium-226 and 10 to 30 µg/l of dissolved uranium.

During the most recent study, the 1971 study,we observed 3 pCi/l of dissolved radium-226 in the creek and 150 µg/l of dissolved uranium. In terms of flow, the flow upstream from the mill in 1971 was 0.1 cfs and downstream at the confluence it was 0.5 cfs.

Dissolved radium-226 and uranium concentrations in excess of natural levels have been observed in the Cheyenne River at a location about 1.5 miles below the mill. I bring out this location because in the 1971 study we observed through the use of dye tracers that this was the point at which Cottonwood Creek was fully mixed with the Cheyenne River. However, due to the additional dilution provided by the Cheyenne River flow, concentrations have been substantially lower than those observed in Cottonwood Creek.

Consistent with the 1964 findings for the creek, the concentration of dissolved radium-226 in the Cheyenne River was 2.5 pCi/l, and we observed 130 µg/l of dissolved uranium.

In terms of the 1971 studies, we saw about 0.2 pCi/l of dissolved radium-226 and 28 µg/l of dissolved uranium.

To summarize these, the 1964 values were about one order of magnitude greater than the background values, whereas the 1971 values were at background levels. This was not surprising, since the dilution factor was about 50-fold. We observed 5 cfs in the Cheyenne River upstream versus the 0.5 cfs in Cottonwood Creek.

What do these results mean? The increases in the dissolved concentrations of radium-226 and uranium in the Cheyenne River during periods of low flow do not pose a potential public health hazard. This results from the nonuse of the Cheyenne River for domestic water supply. However, a comparison of the observed concentrations of radium-226 and uranium with currently accepted standards also shows that the radiological quality of the Cheyenne River is acceptable for drinking water purposes.

Based on the radium-226 concentrations observed during low flow conditions, it seems probable that the annual average concentration of radium-226 in the river does not exceed 1.0 pCi/l. Accordingly, if the Cheyenne River was used as a regular source of drinking water, the resultant intake would only be 5 percent of the transient rate of daily intake for the general population as recommended by the Federal Radiation Council. This recommended transient rate is commonly referred to as the upper limit of FRC Range II.

The fact that the maximum radium-226 concentration observed in the Cheyenne River was less than the current guideline for radium-226 in drinking water, which is 3 pCi/l, also demonstrates the absence of a potential health hazard from this radionuclide. Similarly, the dissolved uranium concentrations in the river have not approached levels of public health significance. The maximum concentration of dissolved uranium was about 20 percent of the International Commission on Radiation

Protection standard, which is 700 µg/l and was negligible in comparison to the NCRP standard of 22 mg/l.

For the basis of these two uranium standards I refer you to Table I of the conference report. In this table I have given the specifics on how these values are derived from the values recommended for continuous occupational exposure.

Regarding the on-site storage of sand tailings, I believe that some amount of sand tailings are entering the water environment by wind and/or water erosion and this is based on visual observations I made during the July 1971 study. For example, in the case of the storage area which we have designated Pond No. 2, it appeared that the sands were drifting toward the U. S. Highway 18 and had more or less breached the dike and were drifting down into the channel of the Cheyenne River.

As I mentioned previously, mercury analyses as well as radioactivity analyses were performed on the water and seepage samples collected during the July 1971 study. In all cases the dissolved--and I might emphasize here dissolved--mercury concentration was less than 5.0 µg/l, and these values are presented as an addendum to the report.

I would like to close with our recommendations.

1. The bottom and sidewalls of the retention ponds

should be sealed to eliminate seepage into Cottonwood Creek and the Cheyenne River.

2. A two-phase program providing for the stabilization and ultimate disposal of sand tailings should be developed with a reasonable timetable for implementation. As a first phase, immediate action should be taken to stabilize the huge bulks of sand tailings stored in Pile No. 1, Pile No. 2, and Pond No. 2 against wind and/or water erosion. The most desirable alternative for the second phase of the program, ultimate disposal, seems to be storage in the excavated portions of the open-pit uranium mine operated by Mines Development, Inc.

3. Monitoring stations should be established on Cottonwood Creek (at the mouth) and the Cheyenne River (downstream from the mill) to determine the extremes in chemical and radioactivity concentrations as well as the annual average radioactivity concentrations. As a minimal effort, weekly grab samples should be collected with analyses performed on monthly composites. Monitoring should be continued after Recommendation 1, above, has been implemented to show the sustained integrity of the sealed ponds. During this stage, the frequency of sample collection could be reduced to monthly grabs.

4. The classification of Cottonwood Creek should be resolved in regard to applicable standards, that is, effluent

limits or receiving water standards. Upstream from the mill the creek is an intermittent stream whereas flow in the reach traversing mill property is maintained by seepage, possible spring flow, and drainage from an abandoned railroad well.

Thank you.

MR. STEIN: Thank you, Mr. Lammering. Any comments or questions?

MR. GRIMES: I have a question which relates to the standard inquiry.

You measured these things in the concentrations of-- the average effects of concentrations in Cottonwood Creek and the Cheyenne River immediately below the mill.

DR. LAMMERING: That is correct.

MR. GRIMES: Did you extend that to a sampling of Angostura Reservoir waters themselves?

DR. LAMMERING: Yes, in the 1971 study, as I mentioned, we did a comprehensive study of Angostura Reservoir. Unfortunately, the results are not available at this time. This is due to the fact that radium analysis takes 30 days in our normal sampling process. We have completed the uranium analyses which I mentioned. In all cases these were background analyses. We have in the past looked at fish on one occasion and these also were background levels. So as of this time we have not seen an effect down in Angostura Reservoir, and this is largely due to the dilution. As I pointed out, we are talking about 5 cfs up around Edgemont and 130 cfs down around the headwaters during low flow.

MR. GRIMES: Yes, and you also have that tremendous quantity of storage in the reservoir usually?

DR. LAMMERING: Right.

MR. STEIN: What you are saying, Dr. Lammering, is, that there is no potential health hazard and yet you are recommending a remedial program.

DR. LAMMERING: Well, I think this is--and the State may want to address this later on in terms of what the permit is for the mill, etc., but the concept in terms of radioactivity, one is to minimize insofar as practical, again looking at the possible long-term uses of this resource, so long as these minimization techniques are feasible and practical and reasonable, and I think this is the case.

But more importantly as well from the rad* standpoint, there is the aesthetic problem here, which is not clearly visible from the road. But this seepage is resulting in a degradation, at least aesthetically, of Cottonwood Creek and the Cheyenne River system.

MR. STEIN: I have some problems here, so I hope someone may be here from the company. But as you described it--it seems to me that what they are doing here is not up to the standard we are requiring for the rest of the uranium mills, i.e., at the minimum we are requiring stabilization. Some of this may be a little technical if you don't understand the industry. I am just going to do it to short circuit this, because I don't know how big the problem is. But they are not stabilizing the piles.

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* Radioactivity

DR. LAMMERING: That is right.

MR. STEIN: And from what I can see of your map here and the heights you describe, it is inevitable that some of it has to blow into the water.

DR. LAMMERING: This is the, I guess you would call it, subjective analysis.

MR. STEIN: Yes, that is right.

DR. LAMMERING: Now--

MR. STEIN: Not that that is not bad. All you have to do is look at this to see you have a big pile of sand, and it blows off when the wind blows--

DR. LAMMERING: Right.

MR. STEIN: --and there is a stream nearby. Now, I don't think you have to--

DR. LAMMERING: Well, I might point out that there is a mill manager who is here, and I believe he is planning to make a statement.

MR. STEIN: All right. The next point is, the other thing we do require on the mills is at least impervious sides and bottoms to those holding ponds. This is a general standard we require for that industry.

The third point I would like to make--and I would like to call that particularly to the attention of Dr. Hayes--personally I have not found that effluent limits or receiving water standards that he talks about in Recommendation No. 5 are sufficient to help us protect against the radioactive buildup or hazard. Here is what happens.

We have found in many cases that the applicable effluent standards were set or the receiving water standards may have been met, but after a long period of time the radioactivity will settle in the sand at the bottom. Or worse, if you add a drinking water source--which you don't have here--it gets into the sand filter of the drinking water intake. With the long half-life of radiation, if you keep building this up on the bottom, it presents a hazard because it leaches out--over how many years? Do you want to give us the half-life for this?

DR. LAMMERING: Radium? Sixteen twenty, about?

MR. STEIN: What?

DR. LAMMERING: Oh, you mean leaching?

MR. STEIN: Yes, leaching. Now, what is the half-life?

DR. LAMMERING: Oh, to bring it out of the sediments? It is relatively rapid on the--

MR. STEIN: No, on the half-life.

DR. LAMMERING: I haven't seen a half-life in terms of leaching. If you are talking about, you know, decay--

MR. STEIN: Decay.

DR. LAMMERING: --decay is 1,620 years, practically forever.

MR. STEIN: That is right, if it stays there. But the leaching out covers a long time.

Now, we have found in other areas where we have looked at the muds on the bottom that the effluent limits were not giving us the right requirement. If you add any radiation, particularly in the form of radium, if you can possibly do it with a reasonable expenditure of funds, the thing to do, I think, is the kind of program Dr. Lammering is speaking about. That involves lining those ponds, either spraying the top of those piles with some petrochemical material that will keep it down, or asphalt, or sodding it over, or making that sort of a knoll, but preventing those piles from blowing. There you are going to prevent the possible buildup of the radiation in the bottom sediments of the river, which I think may be more significant than the effluent limits and just checking the water standards. As he pointed out, we don't have it working yet. But our experience again has been that where we can detect radiation in the effluent or radiation in the receiving waters, we begin to detect a higher value in the riverbed or in the streambed, and this lasts for at least a reasonable period of time before it leaches out. That is what we have to worry about.

Would you agree with that?

DR. LAMMERING: Yes. As I say, if I was going to put a priority on these recommendations, sand tailings is the No. 1.

MR. STEIN: Right.

DR. HAYES: No. 1 would be the one that you would recommend as the priority, I assume?

DR. LAMMERING: No, No. 2, sand tailings deposition.

MR. STEIN: No. 2. I think the sand tailings are the No. 1. In other words, unless they are going to bury them under a sod cover, you can spray those things pretty fast and stop those piles from blowing, and that is the No. 1.

The No. 2 might take a little longer. You are going to have to drain one of the ponds at a time. Then you are going to have to line it with an impervious layer or put something in there so that when the liquid hits it, it in turn will be transformed to an impervious layer. But these are well within engineering capabilities, and as I understand it, Doctor, most of the uranium mills have this kind of protection in one form or another. If what Dr. Lammering is saying is so, I am not sure that this operation is up to the generalized standard of the industry in providing this kind of protection and I just raise that.

Are there any other comments or questions?

If not, thank you very much, Dr. Lammering.

MR. DICKSTEIN: Mr. Chairman, this completes the Federal presentation.

MR. STEIN: We will take a 10-minute recess.

(RECESS)

MR. STEIN: We will reconvene.

South Dakota will make its presentation and call on its invitees now. We plan to go to about 5 o'clock and then recess until tomorrow.

Dr. Hayes.

DR. ROBERT H. HAYES
STATE HEALTH OFFICER
SOUTH DAKOTA DEPARTMENT OF HEALTH
PIERRE, SOUTH DAKOTA

MR. HAYES: Thank you.

Mr. Chairman, I have a prepared statement, which I would like to have you introduce into the record, and it has been submitted to you prior to the meeting.

MR. STEIN: Without objection, this will be entered into the record as if read.

(The above-mentioned statement was read by Dr. Hayes as follows:)

DR. HAYES: My name is Robert Hayes and I am the State Health Officer and head of the South Dakota Department of Health. I am licensed to practice medicine in the State of South Dakota and have been a practicing physician for 17 years.

As State Health Officer, I am Chairman ex-officio of the South Dakota Committee on Water Pollution. However, my presentation will be restricted to the hazards of mercury to humans and to the recommendations relating to mercury in fish as presented in the two Environmental Protection Agency reports on mercury in South Dakota. Mr. Marvin O. Allum, representing Mr. Charles E. Carl, Director of the Division of Sanitary

Engineering and Environmental Protection of the South Dakota Department of Health, will discuss other aspects of the aforementioned reports for the Department of Health and the Committee on Water Pollution.

As State Health Officer I have statuatory and moral responsibilities for the health of the citizens of South Dakota, and I can assure you that I do not treat those responsibilities lightly. Therefore, when I tell you that I believe there is a mercury problem in South Dakota but that I do not believe there is a mercury toxicity problem in South Dakota, that is exactly what I mean.

It has been said that the most consistent product of the mercury problem has been confusion, and much of that confusion has come about because of the controversy over the Food and Drug Administration's insistence that fish containing 0.5 ppm or more of mercury are to be considered dangerous, in spite of the fact that to the best of my knowledge there is no clinical evidence to support such a limit. And I don't want to make that point again and I say that there is no clinical evidence. Without exhausting the list of those in the medical profession and other science disciplines who have publicly taken issue with the FDA limit, I call your attention to the following eminent physicians:

Dr. Leonard J. Goldwater, School of Medicine, Duke University

Dr. Thomas B. Eye, St. Clair, Michigan

Dr. Henry Schroeder, School of Medicine, Dartmouth University

Dr. Frederick J. Stare, Chairman of the Department of Nutrition, Harvard University

Dr. Jack Kevorkian, Pathologist, Saratoga General Hospital, Detroit, Michigan

In all the confusion, largely overlooked is the fact that the 0.5 ppm limit was adopted as an interim guideline limit and was based on the only known and substantiated occurrences of mercury poisoning through the ingestion of contaminated fish and shellfish in Japan. You have heard this report. I think it bears out what we said. The recent case of the New York woman who ate large quantities of swordfish and supposedly exhibited symptoms of mercury poisoning has been publicly questioned by a number of prominent members of the medical profession, including Dr. Leonard J. Goldwater and Dr. Thomas B. Eye. The fact that there apparently has been a spontaneous remission of supposedly irreversible effects tends to support their skepticism.

Now, let me make it clear that I am not criticizing the original establishment of the interim guideline limit at 0.5 ppm when so little was known here in the United States about the problem. I suspect that if I had had the responsibility for setting the limit, I too would have selected a level that, as FDA Commissioner Charles C. Edwards has stated, "offers a substantial margin for safety." But somewhere in all the furor the FDA limit has graduated from an interim guideline limit, pending investigation to determine the true limit, to an absolute "don't-question-it this-is-it" limit without any more clinical evidence to support it than it ever did have.

Also largely overlooked or ignored is how much methylmercury is ingested in a period of time determines whether mercury poisoning will occur. If the FDA limit is realistic, it would be just as dangerous, I think you will agree, to eat two pounds of fish per week containing the allowable 0.30 ppm of mercury as it would be to eat one pound of fish per week containing 0.60 ppm of mercury. What is by far more important than the fact that some 23 percent of the fish samples from the upper Cheyenne Arm equaled or exceeded the FDA limit is probably how many pounds of such fish were eaten within what period of time? At this point, let me say that the only case of possible mercurialism known from South Dakota was reported to us recently by Dr. Fred Hochberg of the Center for Disease

Control in Atlanta. Dr. Hochberg's laboratory determined a seven- to eightfold level of mercury contamination in a shirt purportedly worn by the individual. Presumably this resulted from exposure during seed grain treatment. Since every doctor in the State has been made aware of the potential problem through our press releases, television shows, radio interviews, and a variety of public and organization presentations, including that of the South Dakota Medical Associations this past spring, the fact that no cases or suspected cases of mercurialism have been reported to us has been most encouraging.

Now, most of us are aware of the special report of the Pesticide Advisory Committee of the Secretary of HEW entitled "Hazards of Mercury" which was assembled on the basis of information obtained in Sweden and Finland. From the summary of conclusions and recommendations I quote, "The levels of mercury contamination found in freshwater fish in Sweden and Finland are similar to those found in such fish in the United States. On the other hand, fish consumption in this country is regarded as 'generally somewhat less' than in the region of Scandinavia." Actually, according to the food and agricultural organization's production yearbook, United States consumption is less than one-third of that of Sweden and about one-half of that of Finland.

To continue, "Medical examinations of heavy eaters of contaminated fish have not revealed conclusive evidence of mercury-related disease in either Sweden or Finland. Nevertheless, the body burdens of mercury of some of those having the heaviest intake of fish in both these countries were as high as the lower levels reported in persons with methylmercury poisoning in Japan. The major conclusion derived from these and other findings was that it seems unlikely that we will find overt (detectable) mercury poisoning from the consumption of fish or other food products as normally marketed in this country." If the modifier "as normally marketed" means less than FDA's limit for fish, that would appear to be one of the most carefully worded and conservative conclusions reached for some time.

Again I call your attention to the fact that the average fish consumption in Scandanavia is from two to more than three times that of the United States. Now, we don't really know what the average South Dakota consumption may be, but our mid-continent location almost certainly assures an average consumption far less than the United States average. This consumption and the apparently large margin of safety in the 0.5 ppm limit are major considerations in my contention that there is no mercury toxicity hazard in South Dakota at this time.

Now, as we became aware of the mercury problem in South Dakota about a year ago, we prepared a Department of Health position paper entitled "Mercury in South Dakota." Although this paper has had wide distribution, including a number of copies to EPA representatives, and contains some of our recommendations as to courses of action, as well as the chronology of the problem, I would like to include it with this presentation as part of the hearing record, Mr. Chairman. The tables referred to in the report have been reproduced in one of the EPA reports and have not been included. I might add that if the State budget had permitted, the action program outlined in the position paper would by now be yielding information upon which a logical decision on the mercury problem might be made.

By now there should be little question as to my reaction to Recommendation Number 5 in the black-cover EPA report or to Recommendation Number 2 of the report presented by Dr. Hassler. I agree with Surgeon General Jesse L. Steinfeld that the mercury problem is a "legitimate area of concern but not a legitimate cause of hysteria," and before we hit the panic button and possibly precipitate another cranberry crisis, a tuna tussle, or a phosphate fizzle, I strongly recommend an action program to determine whether there is or is not a problem.

MR. STEIN: Without objection, that report of yours will be included in the record as if read.

(The above-mentioned position paper follows:)

South Dakota
State Department of Health

MERCURY IN SOUTH DAKOTA
November 5, 1970

I. Based on available evidence, there is no mercury toxicity problem in South Dakota at this time.

A. The Food and Drug Administration rejection level of 0.5 ppm of mercury (Hg) in fish flesh in interstate commerce was established as an interim guideline level pending investigation and research needed to validate a tolerance level (there are no established U. S. or Canadian tolerances for Hg residues in any food products). Reportedly, a safety factor of 20 was used in deriving, emperically, the 0.5 ppm limit.

B. After human experimentation, Swedish workers in 1969 concluded that a daily intake of 120 grams (4.3 oz.) of fish flesh containing 0.5 ppm of methyl Hg would be allowable (safety factor of ten)* This amount of fish is three times the U. S. average daily consumption of fish (and probably at least five times the average South Dakota consumption).

C. Mercury levels in South Dakota fish are given in Table 1, in water in Table 2, and in sediments in Table 3.

It will be noted that the Cheyenne system below Whitewood Creek (which receives Homestake mining wastes) exhibits the more critical levels of mercury in fish, sediments, and water. Although the form in which the Hg occurs has not been determined, it is believed to be the soluble methyl mercury form resulting from biological methylation of insoluble elemental (metallic) mercury. The soluble mercuric or mercurous salts used in seed treatment, crab grass control, fungus control, etc., are not likely to have contributed significantly to the higher Hg levels reported here. The very low Hg levels in eastern South Dakota fish support this conclusion.

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*Berglund, Fredrik, and Maths Berlin. Risk of methylmercury cumulation in man and mammals and the relation between body burden of methylmercury and toxic effects. In "Chemical Fallout", Report of the Conference on Toxicity, U. of Rochester, 1969 (M. W. Morton and G. G. Berg, Eds.).

It will also be noted that Hg is present in some amounts in all of the major streams of western South Dakota. This, together with appreciable amounts in fish not exposed to Whitewood Creek influence, discloses a previously unsuspected widespread distribution of naturally-occurring mercury in western South Dakota. Therefore, the Hg levels in Oahe fish cannot be attributed wholly to Homestake Mining Co. waste discharges to Whitewood Creek (to the Belle Fourche River to the Cheyenne River to Oahe Reservoir).

II. A potential mercury problem does exist in South Dakota.

A. Elemental mercury has been used in gold recovery in the Black Hills since about 1878; it is known that substantial amounts of the metal were lost in the process, particularly in the earlier operations where cruder methods of recovery were employed. Free mercury has been observed in the sediments of several Black Hills drainages by School of Mines personnel and placer prospectors. These mercury "stores", plus the naturally-occurring mercury noted above, portend a problem for some time to come.

Even if all mercury discharges are halted immediately, major storms or spring flushes will disturb the existing mercury-containing stream sediments and expose more mercury to biological methylation. If the rate of elimination of Hg from the sediments occurs at the same rate as its deposition, about 100 years will be required to eliminate the problem.

B. Definition of the extent and severity of the problem will require intensive, and somewhat expensive, testing.

1. The priority item in the definition of the Hg problem is the immediate development of in-State analytical capability. To this time, we have had to rely on Federal laboratories to provide such Hg analyses as could be sandwiched into their own analytical responsibilities. An adequate testing program will require that several State laboratories be programmed for analyses of Hg in various substances:

    a. University Medical School and State Chemical Laboratory - Primary responsibility for determination of Hg levels in humans, investigations of the physiological effects of Hg in humans and other forms of life, and other such medically-oriented studies. The laboratory should also have the responsibility of periodic validation of the techniques and results of the other laboratories.

    b. School of Mines Experiment Station - Primary effort in the delineation of Hg occurrence in fish, waters, and sediments of western South Dakota with emphasis on the streams directly draining the Black Hills.

    c. Station Biochemistry, S.D.S.U. - Primary effort in determining Hg occurrence in eastern South Dakota plus Hg occurrence in game birds, waterfowl, and game animals.

2. The levels of mercury in the blood and urine of a cross-section sample of South Dakotans should be determined by the State Public Health Laboratory. If the results indicate the need, a more intensive testing of Hg in humans on an area basis (e.g., those in the Cheyenne drainage system)

should be undertaken. The International Committee on Maximum Concentration of Mercury Compounds recommends a ceiling blood level of no more than 10 micrograms of Hg per 100 milliliters of whole blood*.

3. Greatly expanded sampling of water and sediments is needed to determine the areal extent of Hg distribution, with particular emphasis in the western portion of the State. Particular attention should be given to public and private water supplies.

4. The testing of fish flesh must be broadened considerably with particular attention to temporal as well as areal distribution of affected fish to more adequately define the toxicity hazard.

   Attention must be given to Hg levels in relation to species, sizes, and habits of fishes. Preliminary findings indicate the larger individuals of the more predacious (fish-eating) species acquire more mercury than the smaller predacious fish or the non-predacious species. Also, there appears to be a gradual build-up of Hg in fish flesh during the summer; presumably, this is because ingestion of mercury-carrying foods during this period of active feeding results in a greater intake than elimination (the half-life of Hg in fish is about 70 days; i.e., if a fish ingested 10 milligrams of Hg today, 5 milligrams would be eliminated in 70 days, half of the remaining 5 milligrams of Hg would be eliminated in another 70 days, etc.).

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*Report of the International Committee on Maximum Allowable Concentrations of Mercury Compounds. Arch. Environ. Health, Vol. 19, Dec., 1969, pp. 891-905.

5. If possible, studies should be directed toward the avenues of transformation of metallic mercury to soluble mercury, the pathways of the soluble mercury through the food chain and into the fish, the possibility of direct absorption of soluble Hg through skin and gills of fish, etc. The food-chain avenue seems most likely in view of the greater levels of Hg in predacious species as noted above.

6. The possible occurrence of Hg in upland game birds, waterfowl, and game animals needs investigation.

   The occurrence of Hg in domestic food supplies is under study by the U.S. Food and Drug Administration as part of that agency's "Total Diet" investigation. Duplication of investigative effort should be avoided as much as possible.

7. In the budget for fiscal 1972, the State Department of Health has requested funds to accomplish the surveillance of Hg levels in fish, waters, and sediments of the Cheyenne system.

   The Experiment Station of the School of Mines has applied for a Federal grant to begin a study of the distribution of Hg in western South Dakota, including public and private water supplies, sediments in depth, and Hg occurrence in fish and wildlife. *This grant has not yet been approved*.

III. What can be done to minimize or eliminate the mercury problem?

A. Even if nothing more is learned than is known now, the first step must be the *elimination of any further man-caused mercury discharges to the environment*. In South Dakota, the only appreciable Hg discharge known is from the amalgamation process of the Homestake Mining Company.

B. Methods must be explored for preventing the Hg already in the Cheyenne system sediments from getting into Oahe Reservoir. Since almost all of the Hg is in the sediments (compare values in Tables 2 and 3 for same locations), damming of the Cheyenne River at some suitable site above the Cheyenne Arm of Oahe Reservoir would virtually eliminate further Hg incurrences to the Reservoir.

C. Once containment of the existing Hg sources is accomplished, investigation of methods of removing Hg from the Cheyenne can be undertaken.

D. Until such time as containment and removal of mercury can be accomplished, if no markedly greater levels of Hg are detected man can safely eat at least a quarter of a pound of fish per day every day for the rest of time.

Based on values observed in South Dakota waters (Table 2), man can drink all of the water he would otherwise drink to any extent humanly possible.* Present evidence indicates he could not drink an amount that would be toxic even if he were a human filter.

E. In contrast to inferences made by other agencies, there is no mercury toxicity problem evident in South Dakota at this time.

IV. Chronology of the mercury problem in South Dakota.

A. Although the toxicity of mercury salts has been recognized for years, metallic mercury has not been considered a problem except where occupational exposures were involved (mining, metallurgy, etc.). Even the occupational exposures to metallic mercury were considered to involve the inhalation of mercury vapors only since the absorption of metallic mercury through the skin is so slow as to be considered of questionable importance.

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* The only waters exceeding the USPH limit of 5 parts per billion are Whitewood Creek and the Belle Fourche River at S.D. 79 bridge; in both places, the extremely high level of solids would discourage any use as drinking water. However, in both places, if the sediments are removed, the Hg content drops to less than one part per billion.

The discharge of elemental mercury in industrial and other wastes, although not encouraged by regulatory agencies, was not believed to be a matter of concern since it is common scientific knowledge that elemental mercury is insoluble in water! In fact, in the report of the National Technical Advisory Committee on Water Quality Criteria to the Secretary of the Interior, published in 1968, mercury is not even mentioned except for four short paragraphs on the toxicity of mercury salts in sea water!

B. In the past twenty years there have been but two known occurrences of human mercury poisoning from the consumption of contaminated fish. For various reasons, these incidents were unknown outside of the areas of occurrence in Japan until recently; the first report in the scientific literature about the problem was published in 1966.

C. In the early 1950's, Swedish conservationists became alarmed about the wide-spread use of alkyl mercury compounds (including methyl mercury) as seed dressings in agriculture and the effects of these mercury compounds on bird populations. By 1965 investigations had proven that agricultural mercury was responsible for the drastic decrease in wild bird populations, and that mercury had invaded other parts of the environment, including fish. Because of the elevated mercury levels in the fish in most of the fresh and coastal waters of Sweden, in November of 1967 the fish were declared unfit for human consumption.[4] The mercury problem and the investigative work in Sweden were not widely publicized outside of the European area; as a result, very few American scientists were aware of the problem.

D. In 1967, a Swedish doctoral candidate at the University of Western Ontario began a study of mercury use in Canadian agriculture and industry and the effects on wildlife. In the first week in March of this year, 1970, he collected 42 fish from Lake St. Clair (lying between Michigan and the Province of Ontario, Canada) for Hg analyses. On March 24, 1970, acting on the basis of the mercury content of the 42 fish, Canadian officials seized 18,000 pounds of walleyes taken from Lake St. Clair and declared these fish to be unfit for human consumption. March 24, 1970, then, marks the date that mercury contamination in the lower Great Lakes and the United States first became public knowledge and also marks the beginning of a massive investigative program by State and Federal agencies to determine the extent and severity of the mercury problem in the United States.

E. On April 10, 1970, all 17 district offices of the U. S. Food and Drug Administration (FDA) were directed to begin investigations of sources of mercury and levels in fish. On April 29, 1970, personnel of the South Dakota Department of Game, Fish and Parks collected the first samples of South Dakota fish from lakes in Day, Deuel, and Marshall counties for Hg analyses by FDA. On May 21, 1970, personnel of the U. S. Bureau of Sport Fisheries and Wildlife collected the first fish from Oahe Reservoir for Hg analyses by FDA. On June 17, 1970, Willis Banks, Federal Water Quality Administration (FWQA), Missouri Basin Regional Office, Kansas City, reported to us by phone the results of the analyses of the Oahe Reservoir fish samples.

F. Because the Oahe results approached the FDA interim limit of 0.5 ppm., we immediately contacted the FDA laboratory in Denver and made arrangements for the analysis of 24 more fish samples. Samples were collected in late July and early August by personnel of Game, Fish and Parks and the Bureau of Sport Fisheries and Wildlife from the Cheyenne system - including the Cheyenne Arm of Oahe - as well as two other Missouri reservoirs. On September 16, 1970, the results of the tests were received, and several fish were found to have markedly exceeded the 0.5 ppm FDA limit.

Once again we contacted the FDA Denver laboratory and were able to persuade a commitment for another 12 samples. On October 13 and 14, two collections of fish from the Cheyenne Arm were made by Game, Fish and Parks personnel, and the results were received from FDA on November 2, 1970. In all cases, the results of our fish sampling were provided directly to FWQA by FDA.

No further sampling has been possible because the FDA Denver laboratory can no longer provide the analyses due to their own program commitments.

V. Chronology of Federal action.

A. Water quality standards for South Dakota were adopted by the State Committee on Water Pollution on February 16, 1967. Included in the standards was a schedule for the completion of waste treatment facilities by Homestake Mining Company by July 1, 1972. The standards, including the Homestake schedule, were approved by the Secretary of the Interior on August 7, 1967; the Federal Water Quality Administration has known of our requirement for the treatment of Homestake wastes since the standards were first submitted to that agency for review and approval on May 15, 1967!

B. As noted in section IV-D, above, no one was aware of a mercury problem in the United States until March 24, 1970, and no one was aware of a mercury problem in South Dakota until September, 1970.

C. In early July, 1970, Secretary of the Interior, Walter J. Hickel sent a telegram to the governors of 17 States (not including S. D.) asking that they take action to halt Hg discharges in their States. On

July 26, 1970, Secretary Hickel asked the U. S. Department of Justice to begin legal action against 10 firms found to be discharging over a pound of mercury per day following testing in part done for FWQA by the U. S. Geological Survey.

This action was taken under an obscure provision in the 1899 Federal Rivers and Harbors Act which requires a permit be obtained from the Corps of Engineers before the discharge of any foreign substance or pollutant (except municipal sewage) into navigable waters of the U. S. (it should be noted that FWQA considers essentially all waters to be navigable whether they are in fact navigable or not). Since the Corps of Engineers has issued only a dozen or so such permits since 1899, almost every industrial waste discharger in the country is liable.

Interestingly, apparently almost no one was aware of the permit provision of the 1899 Act (Section 13) until it was brought to public attention by Congressman Henry S. Reuss of Wisconsin in a House Government Operations Subcommittee Report earlier this year.

D. During the week of August 10, 1970, we participated in a pilot plant study of the treatment of Homestake wastes prepared by the Company's consulting engineers. We invited representatives of Game, Fish and Parks, the Bureau of Sport Fisheries, and FWQA to observe the pilot plant study and to offer any comments or criticisms they might have. All seemed satisfied with the testing and the results. During the several days of the study, the FWQA representative, Dale Parke, secured Hg samples from various Homestake operations and test plant streams (through our request for Company cooperation) and from Whitewood Creek, the Belle Fourche River, and the Cheyenne River. The results of these tests (Tables 2 and 3), together with the fish tests for which we made arrangements, evidently are the basis of FWQA action (see section V-F, below).

E. On August 10, 1970, in company with the consulting engineer and the FWQA representative, we met with the Homestake manager, James Harder. We informed him of the mercury in Oahe fish, advised him of the Federal action being taken against the 10 firms (section V-C), and suggested that his Company begin planning for removal of Hg from the wastes. Mr. Harder replied that it would be impossible to eliminate Hg immediately without closing the mine and indicated that at least two years would be needed to provide treatment of Hg or alter plant operations so as to reduce or eliminate the use of Hg.

F. In late September, 1970, we learned that Homestake had been asked to discuss the mercury problem with FWQA in Washington, D.C., on October 14, 1970; we were advised of the meeting by FWQA on October 1.

On October 20, 1970, Mr. Harder advised us as to the gist of the meeting. It was his understanding that FWQA wanted Hg discharges reduced to not more than 8 ounces per day but was not pressing for instant compliance and that it was agreed that Homestake would press their research during the following six months after which another six months might be required to implement treatment (FWQA representatives deny any such arrangement).

By letter of November 3, 1970, FWQA requested Homestake Mining Company to eliminate the discharge of mercuty by January 14, 1971, and indicated enforcement action would be taken by the U. S. Department of Justice (under the 1899 Act) if the Company failed to comply.

DR. HAYES: Thank you.

MR. STEIN: Any comments or questions?

DR. HAYES: Somehow in all the seriousness of the problem which I think we have heard, and I do realize, I think that our young people do have a marvelous sense of humor. Since I have a house full of them at home, I get exposed to all kinds of good literature. And one of the things that I happened to bring along, just to sort of depart from seriousness and go to levity, is a quote from the National Lampoon, and I quote, March 1971, the National Lampoon:

"The Union Chemical Company has announced that a shipment of 5,000 gallons of ultrapure mercury destined for its giant petrochemical facility in Stumpton, Indiana, was spoiled when a worker, during a routine inspection, inadvertently dropped a tuna fish sandwich into the tank car in which it was being transported. Company spokesmen said the mercury was found to contain 0.5 ppm tuna and is considered totally unfit for industrial use." (Laughter.)

Now, I don't want to have any of you for any reason think that the little departure to levity means that we do not think this is a serious problem. We certainly do. In fact, the reason for all of you to come and the reason for this time is that we do wish to address ourselves to it.

I do make these comments so that you will all hopefully take into consideration there may be two sides to the story and that somehow we have to get at what is the truth and what is the thing we should do, and hopefully in the next few hours and days we will come to those deliberations.

Thank you.

MR. STEIN: Thank you.

Are there any comments or questions?

You know, Doctor, let me say one thing. One of these things I did live through with the HEW Secretary, at that time Arthur Flemming, was what you referred to as the cranberry crisis. I don't know if that is like the others. But in that cranberry situation, I think--and this was a Food and Drug thing, so they should talk about this because I never worked with the Food and Drug Administration, but I worked very closely with them at the time--the cranberry growers were using the chemical aminothiazole, if I remember right--

MR. RONK: Triazole.

MR. STEIN: --and they were using it as a weed control on cranberries. There was a voluntary agreement that the cranberry growers would not use this as a weed control, and then investigation by the Food and Drug showed that they were in fact using it. So the Secretary reacted to what he thought was a breach of faith and lowered the boom.

I think that may be a little different than some, because I don't think the panic button was pushed. Voluntary agreement was made, and I don't think this was ever repudiated or changed, it was just broken, so the Secretary reacted.

But are there any other comments or questions?

If not, thank you very much.

Would you continue with your presentation?

DR. HAYES: Yes. I would like to call Mr. Keith Wilcox, who is the Executive Secretary for the Great Lakes of South Dakota Association.

KEITH WILCOX, EXECUTIVE DIRECTOR
GREAT LAKES OF SOUTH DAKOTA ASSOCIATION
PIERRE, SOUTH DAKOTA

MR. WILCOX: Mr. Chairman and conferees, I am Keith Wilcox, Executive Director of the Great Lakes of South Dakota Association, presenting a statement for that Association in regard to the mercury in the Cheyenne River watershed.

And Mr. Chairman, I have copies of the statement for each of the conferees.

MR. STEIN: Yes.

K. Wilcox

MR. WILCOX: I would like first to acquaint the conferees as to the structure of the Association to better explain our interest in this matter. The Great Lakes Association is a nonprofit group that is interested in the general development and use of the Missouri River reservoirs commonly known in South Dakota as the Great Lakes of South Dakota. We represent members not only along the Great Lakes but from the entire State, along with four Indian tribes that border these waters. Some of our members are from the business communities of the area and the remaining membership comprises the civic-minded individuals interested in improving the economic conditions of our State.

South Dakotans are just becoming accustomed to the fact that our State is no longer an arid State but that we now have more shoreline than either coast of the United States; that we now have over an acre of surface water per citizen. They are becoming aware of the fact that this water is having a tremendous impact on the economy of the State through its effects on the water use for outdoor recreation, irrigation, municipal water supplies and other related purposes. We are experiencing the effects of over 6.5 million visitations to the Great Lakes of South Dakota annually.

Sportfishing alone has accounted for a considerable growth in those related industries. The Department of Game, Fish and Parks in South Dakota estimates that the revenues generated from sportfishing range in the $20 million category. However, some of the related business along Lake Oahe reported a 70 percent decline in business last year when the mercury scare first hit the press. The fishermen were worried and they simply did not fish the Cheyenne or the lower reaches of Lake Oahe, and many people still have a question in their minds. It was only last week that such an individual commented to me that he fished the Cheyenne area of Oahe whenever he went fishing, but since the mercury matter came up he goes elsewhere.

Our Association has always considered the water quality of these lakes as the most important factor of the future development along the lakes. No single factor or single individual or business can be allowed to pollute these waters for any reason.

We are happy to see that this conference has been called and that you people are going to investigate this problem for what it is.

We have some question as to the accuracy of the first report, in that in some cases the determinations were made on one fish only. This does not seem like a representative sample to us. If there is a mercury problem on the Cheyenne, it would seem that in all probability there is mercury pollution. We would then like to have the extent of the problem determined. By this we mean the current problem along with the future effects of any accumulation of mercury on fish and water quality that might be caused from accumulated deposits. Then, of course, we feel that it is imperative that measures be taken that would assure that the current problem be taken care of and also assurance that any future movement of accumulated mercury would not be a pollutant to the water of Oahe Reservoir.

One of the very important points of consideration must be the amount of mercury that can be considered a threat to human health. This is a serious matter in that any use of inaccurate amounts could have serious effects on the economy of an area without any benefit to the human factor involved.

An interesting news article appeared this past week about work done at the Saratoga General Hospital in Detroit, Michigan. In general, these researchers found that mercury levels in humans is declining and that the mercury scare may be unwarranted. They criticized the 0.5 ppm set by the Food and Drug Administration, stating that there is no data to support such a level and that it was based on "emotionalism and ignorance."

This may or may not be true. Our only point is that there are differing opinions on the matter and we would hope that this conference would have absolute scientific facts before any conclusions are reached or publicized.

I would conclude this statement with some recommendations that we would like to offer as guidelines for the activities of this conference.

1. Conduct a more thorough testing of fish from the Cheyenne system.

2. Determine fish consumption by South Dakota and of fish taken from the Cheyenne system.

3. Determine what levels of mercury are dangerous to human health.

4. Determine the extent of mercury deposits in the Cheyenne and Belle Fourche Rivers and their effects on fish and water quality in the future.

If you can establish the answers to these four questions, you will then clear up the confusion that exists. Now we have people in positions of authority claiming one thing and other people of authority claiming something else and the average person not knowing what to believe.

Before I conclude this statement, Mr. Chairman, I would like to address myself to a matter that has come up here today and that is Recommendation No. 5 of the black report wherein the Cheyenne system would be marked as being hazardous to human health, and I guess simply I would have to say this, that if this conference would recommend that that action be taken, I think then that we could assume that you have accepted the 0.5 ppm as hazardous to health and that we do have a severe mercury hazard in the State of South Dakota and that we would then hope, sir, that you would give the highest priority to the correction of that problem, whatever steps must be taken. The reason I say these things is that Lake Oahe has some of the purest water in this Nation today and the purity of that water is the future of that lake and we certainly would not want to see it decline in its quality to any degree at all. So this, sir, we would hope you would take under advisement and consideration.

And with that I would like to thank you for the opportunity of appearing before you and we do hope that you have a very successful conference.

MR. STEIN: Thank you, sir.

Are there any comments or questions?

I have one comment, and I really have, after the first one, a real serious comment. You know, Dr. Hayes said about the average fish consumption, "We don't really know what the average South Dakota consumption may be, but our mid-continent location almost certainly assures an average consumption less than the U. S. average." That is taking advantage, really, of the Midwest.

You, sir, say, "South Dakotans are just becoming accustomed to the fact that our State is no longer an arid State but that we now have more shoreline than either coast of the United States." I recognize that there is a little more water supplying the fish for each coast than the coastline. But in a sense I think you have to recognize we all have water.

The point I want to bring out and I think to all the people here, you talked about four things we have to do, and I personally would tend to agree with these four things. These four things have been suggested in other areas.

Now, conduct a more thorough testing of fish, determine fish consumption, determine levels of mercury dangerous to human health--that third one is taking a real big bite--and determine the extent of mercury deposits in Cheyenne and Belle Fourche Rivers and their effects on fish and water quality in the future.

I would suspect, sir, that we may not be able to get definitive answers to those four questions. And these four questions that you ask are not only applicable here but applicable to every other place where we have this mercury problem. You just change the names. I would suggest that we are not going to be able to have the answers to those questions in the near future or certainly by the time we have to reach the conclusions of the conference.

I think Dr. Hayes put his finger on it. Knowing this, we are going to have to come up with a determination--and as he put it, no single industry or group of industries should be allowed to put mercury in--of what we can do reasonably to reduce the amount of mercury getting into the waters.

And secondly, if the problem is sufficient to take some interim measures, whatever they are, to protect the public health--and if it is,I am sure Dr. Hayes will be the first to say it--but what I would like to ask you and the rest of the people, because you are going to have to understand to bear with us, I think Dr. Hayes and the rest of the panel would love to have the answers to these four questions. If we did we could arrive at the conclusions real fast.

But the difficulty with the kind of thing we are faced with and just running a practical administration, we are going to have to make some determinations, perhaps tomorrow or the day after or whenever we do it, before we have the answers to that. We are going to have to do the best we can under the circumstances.

I want to make this clear because I don't want to promise too much. Again, let me say your questions are good but we are not going to have the answer to those questions immediately or in the very near future.

MR. WILCOX: I am sure of this, sir. And because you will probably have to make your decisions, like you say, in the next couple of days--

MR. STEIN: Yes.

MR. WILCOX:--I would hope, however, that if these things are still a question at the time that your decisions are made,that you through some action could provide for or implement the activities that would be necessary to ultimately come up with the answers to these questions. This is why I posed them as I did, sir.

MR. STEIN: Right. Thank you very much, sir.

Dr. Hayes.

Wait a minute.

MR. RONK: Let me say one thing in all sincerity. There has been a great deal of controversy in the papers and there will continue to be a great deal of controversy in the papers about the mercury in foods. It is a sensational-type subject. It is a subject that everyone feels that they have an opinion about. But the longer that you are associated with these problems,the more you find that there is less confusion than there would appear to be.

For instance, the reports that were in the Denver papers and Minneapolis papers on the autopsy specimens from the Detroit, Michigan, area. One of my staff talked to the senior author of this paper on Thursday and many things are left out of the study and then broad conclusions drawn. For instance, there are 59 autopsy studies of people of various ages, of various sexes, from 1913 until the present. They are primarily samples of tissue that would not be a good indicator of methylmercury; there are very few brain tissue samples involved. There is a complete disregard of the wide use of mercurials in drugs in the United States before 1930. Calomel was the drug of choice as a diuretic for the kidneys. There are many mercurials that were used in combination with other drugs, such as there was a combination called Guy's pills for dropsy; there were many nostrums, many ointments. All of these would tend to concentrate in these organs.

The thing I think that is significant about this, I am not saying that this isn't a useful piece of information, but if you have a useful piece of information we would be more than happy to consider it in our deliberations. We do not exclude people from the outside when we decide on guideline features.

And as far as the scientific community is concerned, several of the people that are mentioned in Dr. Hayes's report--for instance two of the people that are mentioned here were on the panel of toxicologists that we brought together before we put out the swordfish press release, Dr. Stare and Dr. Eye. We would welcome any information, any facts that anybody can bring to this particular issue, because we would like very much to find out that methylmercury is not toxic at the levels that we are talking about. We would like to have proof of that.

The other factor to consider is when we are talking about foods as opposed to drugs that there is no health benefit ratio, that these are things that people can do without. And if a serious challenge is going to result from use of these commodities,that it is probably not justified.

There are many millions of dollars that have been lost because of the stand that we are taking,and there has been great dislocation to the fishing industry in the United States and the fishing industry of the world because of this. We don't do these things lightly and we don't do them, we hope, on the basis of lack of information. We do this on the best scientific knowledge that is available when we make these decisions. And if any additional information comes to light, we will change our position. We are not locked into this position.

We are trying to develop as best we can the types of information that we have to have to decide that a compound in a food has some degree of safety. But this takes a great deal of time and, as Mr. Stein pointed out, it is going to take time before we have these answers. But we are going to have to make decisions and very hard decisions in the interim.

MR. STEIN: Thank you.

MR. GRIMES: Mr. Stein, I have a question.

MR. STEIN: Yes.

MR. GRIMES: Dr. Hayes called attention to the fact that initially this was an interim guideline. Now, we all know in these kinds of situations that the tendency, once a figure is actually established, that this becomes the Bible. I think that Dr. Hayes has a particular and pertinent point for us in this conference--

MR. RONK: I think this is--

MR. GRIMES: --to consider this to be just as it was originally established by FDA and not extended beyond the meaning that they subscribe to it.

MR. RONK: Well, I think interim was a word that was used in one of the original press releases and it is a public relation man's word. There is no such thing as an interim guideline. Once a guideline is written it is a guideline until it is changed.

As far as the Food and Drug Cosmetic Act is concerned, the history of guidelines predates the 1938 Act. It goes back to the 1890's when we banned the importation of Burma beans into the United States because they contained glucoside that would release hydrocyanic acid.

In 1940 the Public Health Service established what we called in those days informal tolerances for arsenicals on apples and caused great dislocation in the industry at that time. After the passage of the 1938 Act they became called administrative guidelines, and the constitutionality of having guidelines has been questioned in the courts and probably will be questioned again. But the courts have affirmed that the Food and Drug Administration does have the ability under the statute to establish levels for its administrative officials to effectively enforce the Food, Drug and Cosmetic Act. That is what this level is. It is an interpretation of one of the health sections of the act.

Now, if we would get new information of any kind, we would change this tomorrow. It requires no notice, it requires no public hearing. It is not involved in the Administrative procedures Act, and it is not subject to the Freedom of Information

Act. These are ordinarily confidential guidelines of the Food and Drug Administration and are not released to the public. Once we take an administrative action, then the guideline becomes known.

These are available and have been available to the South Dakota regulatory officials and they--I am not sure of exactly which person, but I would imagine the Department of Agriculture and the--I believe they have a laboratory section in the State of South Dakota. They would be our subscribers to our guidelines; they have the complete package.

MR. GRIMES: Well, the real point that I had to make, of course--

MR. RONK: But it is not permanent.

MR. GRIMES: --is recognizing that these are the current guidelines--

MR. RONK: Right.

MR. GRIMES: --which were used for administrative purposes.

MR. RONK: Well, I think--

MR. GRIMES: At the same time, in EPA's black book report we have before us this 0.5 was taken as an absolute demarcation line between those which were all right and those which were all wrong. Now, it is not quite that sharp.

MR. RONK: No, no guideline level is. But the courts have ruled that it is not arbitrary when you do this as long as they can determine the minimums.

MR. STEIN: Correct.

MR. RONK: But you have to draw the line some place, whether you are talking about rodent pellets and filth elements in wheat, whether you are talking about diethylstilbestrol levels in red meat, whether you are talking about mercury in fish flesh or PCB in eggs. The lines have to be drawn some place and we try and draw that line at the most appropriate scientific place that we can establish,and that is what this 0.5 represents.

If we find a more appropriate place than 0.5, this guideline will be changed tomorrow. It only requires for the Commissioner to change his mind to change this guideline.

MR. DICKSTEIN: For the EPA and the black report, all we can do in EPA is reflect the best knowledge of our sister Agency, the FDA, and as long as the FDA indicates that this is the guideline, we are going to abide by it.

MR. STEIN: Go ahead.

DR. SHIBKO: All the available information that we have had since the original guideline was made has tended to support the guideline.

MR. STEIN: Right. I know we have the problem, but I think this warrants some discussion here in dealing with this thing. But I also think that Dr. Hayes has put his finger on it, and let me go through just in the words that he said.

He said, "Now, let me make it clear that I am not criticizing the original establishment of the interim guideline limit at 0.5 ppm when so little was known here in the United States about the problem. I suspect that if I had had the responsibility for setting the limit, I too would have selected a level that, as FDA Commissioner Charles C. Edwards has stated, 'offers a substantial margin for safety.'"

Now, that is fair. And the point is, I think as Mr. Ronk says, we have to set a limit somewhere.

Then Dr. Hayes goes on and he says another thing he thinks is fair. He says, "The apparently large margin of safety," which he says he would have done, "in the 0.5 ppm limit are major considerations in my contention that there is no mercury toxicity in South Dakota at this time."

O. K. Now, he says administratively he would set this margin of safety, also points out there is a contention of no mercury toxicity.

I would submit to you, gentlemen, that you have a Public Health Service drinking water standard. If you took any of the numbers, you would find about the same kind of rationale that we have given about mercury, i.e., it came down to a certain number of toxicity, then they divided by 10 for a safety factor and there we were, and we are doing this.

And I agree with you, Mr. Grimes, in that I have been around in this business for 25, 30 years, and I have always looked at these big safety factors and raised the question time after time about the apparent large measure of safety--where does that lead us, how long are we going to go with this. Also I have accepted as a fact of life that when we all say we are going to hold ourselves open to new information, it is rare that this new information comes, and we get set with something in the drinking water standard.

I would suspect that maybe mercury has this kind of push, but in a lot of fields I think the change in these requirements, if we are going to get it, is going to be based on hard toxicological or medical evidence. And I also have the suspicion, Doctor, that this is one of the less glamorous fields of medicine. We don't attract a lot of people to do this. When you get a level of lead or arsenic or mercury or what-have-you in drinking water, the hard evidence doesn't come and it doesn't change.

Now, what happens is that we do know at the levels that we have set that we are not getting any indicated hop, and I think we rely on the Food and Drug Administration on the foods. I think they have done a superb job, in the sense that if you consume a food within the limits they say is safe, you are not going to get into trouble. My notion of what you might want to say is that they are a little too cautious, and they don't have to set that type of limit but can go further.

Again I think, and we had this from Mr. Dickstein, since we are an operating Agency, it behooves us in operations to take the Food and Drug administrative determination and apply it in our work because they are the experts, particularly when in a case like this 0.5 ppm of mercury their procedures have been upheld by the courts. As far as I can see--again I don't want to argue this philosophically--but administratively that reasonably seems to me to be the law of the land.

MR. GRIMES: You recall my comment was associated entirely with the practicalities of the situation, not with respect to the actual choice of 0.5 ppm as being a guideline standard. I was merely pointing out that in practical application--

MR. RONK: This is absolutely true, as Mr. Stein pointed out.

MR. GRIMES: O. K. Now, let's take a look at it.

We are taking this particular quantity as a concentration in fish flesh. We are transferring that into the food chain for humans and applying it as a dangerous thing for human life. See? All right.

Now, there are a couple of other variables other than just the standard. First of all, we usually rely upon average intake of fish and its effect upon human life. We have talked about that quite a bit today.

I lost my thought.

But it is in the standard applied. If we are going to use the average intake we ought to be thinking in terms of the average concentration in the fish that have been caught and not necessarily the upper limits or the 0.5 limit or anything else.

We don't know--as was mentioned to us by Keith Wilcox--we don't know how much the sportsmen who fish in South Dakota and their families eat of those fish, No. 1. We don't know what the average concentration of that intake is, and we argue that on the basis of this established figure. And the practical aspect of this thing is what I am pointing out--not any question, because I am not competent to judge in this field, as to whether this is a good figure or not.

MR. RONK: Let me define it for you within the limits of the safety factor. The safety factor runs from the effect level to, let's say, a no effect level. If we were going to apply the tenfold safety factor that Dr. Shibko mentioned, this would only be 60 grams of fish per day.

MR. GRIMES: Sixty what?

MR. RONK: Four hundred fifty-three grams in a pound. That is not very much and that would only be 20 grams over the average diet, the average intake in the United States of fish as defined by the Department of Agriculture, which is 40 grams a day.

Now, if you ate 600 grams, you would be flirting at the effect levels, so that is 600 over 453, that is a pound and a half.

MR. GRIMES: We are talking about pure practical application.

MR. RONK: Now, if you are on a weight watcher diet, you can get right to these figures.

MR. GRIMES: Well, I am sure that I don't eat that much fish, so that means that somebody else is eating more in order to maintain the average. Who is that fellow that is eating more fish, I would like to ask?

MR. STEIN: Here is the point, Mr. Grimes, and I think you have got a key point and maybe we had better understand this while we have the Food and Drug people here.

I think your assumption as to any level, whether it is mercury or cyclamates, as set for the average is not entirely the way I understand the situation. It is set at a level at which one would expect that a substantial number of people or perhaps those more sensitive than others can utilize it. Let's take cyclamates, which were recently banned. Say my wife, for instance, drank one bottle of soda a month; she probably could do it fine. Now, if I drank six bottles a day, we would have a different situation, and it would do me not a damned bit of good to average my soda with hers, since I would be in the group of high level intake.

Now, I think what the Food and Drug people have been saying is they have postulated not theoretical circumstances but circumstances where due to dietary reasons, ethnic considerations of diet, or the economy, or whatever, they feel they have set a reasonably operative level--and I think possibly we should get away from this term interim--an operative level of 0.5 ppm of mercury in fish which they will let go in interstate commerce. I am sure they think they can sustain it, not on the basis necessarily of average because they won't fall back on the average. See, in other words, you get the cyclamates for the weight watchers, or this guy who eats 600 grams of fish. He may be a fellow who just happens to like fish, or can't afford anything but fish. If there is a substantial number of people like that, as I understand it, Food and Drug is going to sustain its requirement. As I read the court decisions, if they do that they are going to make them stick.

MR. GRIMES: I don't question that at all. The real arbitrariness in these things is associated--and I have been in the regulatory business for a longer period of time than you have in different fields, so we have had common experiences here--the real arbitrariness in these matters comes in what percentage of the people's health we are going to protect--

MR. STEIN: That is correct, sir.

MR. GRIMES: --and to what degree we are going to protect the minority in some degree, and the choice as to what that minority is going to be that is still left unprotected, no matter what standard you set.

MR. STEIN: That I would agree with you, in a sense, 100 percent. But we are dealing, and maybe the Doctor should talk to this, with a medical ethic where you don't sacrifice a single life. Then you are dealing in this kind of preventive medicine that most of us have spent our lives in, and we are talking in terms of just writing off a minority, even though it is 5 or 2 or 1 percent of the population. That is a hard thing to swallow.

MR. GRIMES: Speaking facetiously I would say this, that if we are going to protect so that there would be no deaths at all attributable to this particular or any particular thing, I think if we would apply that to all of our intakes we would all starve to death, speaking a bit facetiously.

MR. RONK: Well, I think, though, you have to recognize that our responsibility in Food and Drug Administration is to make the foods as safe as we can.

MR. GRIMES: That is right.

MR. RONK: I think we do have a very good luxury in this particular case in that the fish consumption in the United States is what it is. We wouldn't accept any deaths as acceptable in this situation.

I think the question here that we are talking about is would we accept any injuries as acceptable.

MR. GRIMES: And this is where the choice--

MR. RONK: This is where we are talking about trying. That is why I make the point that as far as food additives situations are concerned as opposed to drug situation, we really don't see much of a health benefit to a ratio involved here, if there is any. If we are talking in terms of drugs, however, we would say that a certain number of people will have to die from side reactions in order to save a majority of people that are suffering from a diseased condition.

MR. GRIMES: Yes.

MR. RONK: But we don't have those types of considerations, fortunately, to make in the food area.

MR. GRIMES: I have one other comment, Mr. Chairman, and then I will close for this go-round, at any rate.

There is a substantial difference between the establishment of public health standards for drinking water and the establishment of this particular level of mercury concentration. The water quality standards are based entirely upon an advisory determination. They are not used for enforcement purposes. That is not true here.

MR. STEIN: Well, we do have an interstate carrier program, but I won't push that. There are areas in the interstate carrier program.

MR. GRIMES: We have a little difficulty here in South Dakota with that.

MR. STEIN: Yes, but this is a technicality. (Laughter.)

Thank you.

DR. HAYES: Mr. Chairman.

MR. STEIN: Yes.

DR. HAYES: May I push for continuing?

MR. STEIN: Yes, go right ahead.

DR. HAYES: I apologize to all. I think we made the point that we set out to make. There was some discussion, let's put it that way, about standards. I do think, as everybody said, we have to go with some. We have been told, I think, without doubt we would go with that one and we will.

But let us go on, if we may, to a presentation from Mr. Allum in our department, who is substituting for Mr. Carl.

MR. STEIN: I really wish you fellows in South Dakota would give Charlie Carl my regards. One of the things I was looking forward to in coming out here was to meet him. I have worked with him for years.

MARVIN ALLUM

PUBLIC HEALTH SCIENTIST

SOUTH DAKOTA STATE HEALTH DEPARTMENT

PIERRE, SOUTH DAKOTA

MR. ALLUM: Mr. Chairman, conferees, ladies and gentlemen.

I am Marvin Allum, Public Health Scientist with the South Dakota Department of Health, and I am substituting for

Mr. Charles E. Carl, who is the Director, Division of Sanitary Engineering and Environmental Protection of the South Dakota Department of Health.

By State statute, as Director Mr. Carl is also Secretary and Executive Officer of the South Dakota Committee on Water Pollution. Therefore, this presentation is made both on behalf of the Department of Health and the Committee on Water Pollution and will concern matters not discussed by Dr. Hayes.

The publication entitled "Report on Pollution Affecting Water Quality of the Cheyenne River System, Western South Dakota," the so-called black report, I believe, prepared by the Environmental Protection Agency and received by us on October 6, 1971, adds considerably to the information available to the participants in this conference. In fact, since it includes the data developed previously by State and other Federal Agencies, as well as the information presented here today by Dr. Hassler, it presents almost everything we know of the mercury problem in western South Dakota. Because of this, and because the report is a public document that has received rather wide distribution, there are a few inconsistencies and inaccuracies we feel should be brought to the attention of the conferees and the public as well. Following that, we will address ourselves to the recommendations presented in the report.

While we recognize that the major portion of the study upon which the report is based was conducted on that part of the Cheyenne system known to have received discharges of mercury, in our opinion there appears to have been a tendency to discount or ignore significant levels of mercury in fish, sediments, and water in locations other than those directly influenced by Homestake mining wastes. For example, a sample of carp from the Redwater River contained 0.58 ppm of mercury. This is shown on page 69 of the report. But on page 22 of the report it is assumed that these fish moved some 50 miles upstream to the Redwater River station from contaminated waters below. This assumption was made despite the fact that carp from an intervening Belle Fourche River station, which is about halfway between the Redwater station and the confluence of Whitewood Creek, only had 0.04 ppm of mercury, while the same species of fish taken from the Belle Fourche about 30 miles below the Whitewood confluence had but 0.18 ppm. Unfortunately, neither the water nor the sediments at the Redwater station were tested for mercury; at least, no such results were reported.

To cite another instance, a number of fish samples were collected in Whitlock Bay of Oahe Reservoir, which is located some 43 miles upstream from the mouth of the Cheyenne Arm. Of the 58 fish samples collected in 1970 and 1971, 10 contained 0.40 ppm or more of mercury and 5 samples contained more than FDA's interim guideline limit of 0.50 ppm. The highest levels found were 0.67 ppm in yellow perch and 0.68 ppm in goldeye. Despite what might be considered to be significant mercury levels, other than the results listed in the appendices on pages 57, 58, 76, 77, and 78, we can find no mention of this elsewhere in the report, although this occurrence is recognized and termed an "anomaly" in the report presented by Dr. Hassler.

Apparently an assumption was made that the fish taken in Whitlock Bay had previous exposure to mercury in the upper portion of the Cheyenne Arm and then migrated some 45 to 50 miles upstream to Whitlock Bay; presumably this could have happened if the eight mercury-contaminated species of fish, members of eight different and diverse families of fish, all had an equally-strong migratory tendency. Granting this to be the case, how then does one account for the significant levels of mercury in the bottom sediments along the south shore of Whitlock Bay as shown on page 80 of the report? Mr. Chairman, at this point I would like to strike the last sentence of the first paragraph on page 3 from the record. I think we got carried away a little bit.

MR. STEIN: That is all right. That sounds just like Charlie. (Laughter.)

MR. ALLUM: In yet a third instance, 1 out of 5 of the fish samples in the single 1970 collection from Angostura Reservoir had a mercury level exceeding 0.50 ppm. These were walleyes collected by the South Dakota Department of Game, Fish and Parks and analyzed by FDA's Denver laboratory. The results are shown on page 59 of the report. Incidentally, in rechecking our data we found that there were six walleyes in that sample instead of one, just to keep the record straight.

This occurrence of mercury above the 0.50 ppm guideline level was treated rather lightly in paragraph 1 of page 1 of the report, "Fish...contained some mercury, but generally at levels less than the FDA guideline." We assume little importance was attributed to this occurrence of mercury because in the single 1971 collection, listed on page 70, mercury was found at less than half the FDA guideline. However, we call the conferees' attention to the fact that the upper Cheyenne Arm is the only locale from which the number of collections made even approaches an adequate sampling in our opinion. And we don't think that the sampling effort there is adequate actually. Even there, where there is no question as to mercury exposure, 77 percent of the samples did not equal or exceed 0.50 ppm, and in several collections taken at that place in 1970 and 1971 no samples at all equalled or exceeded 0.50 ppm. Also, while the report states that mercury was not detected in water samples collected from the Cheyenne Arm in June, page 29, at about the same time, in the Cheyenne River far upstream from the confluence of the Belle Fourche River, mercury at a level of 0.4 ug/l was detected, this at Wasta, shown on page 20. Further, sampling conducted by the U. S. Geological Survey in the Cheyenne River just below Angostura Dam in October of 1970 revealed 0.2 µg/l of mercury. USGS flow records show that October is a period of relatively low flow in the Cheyenne River at that point. We add to the record here the mercury data presented by Dr. Lammering as determined on filtered water samples further on upstream in the Cheyenne River.

We agree with the statement on page 19 of the report that "...fish exposed to minute mercury concentrations may accumulate it in their tissues...", but we are somewhat puzzled by the fact that the occurrence of mercury in waters other than those receiving mine wastes was given so little attention. There are a number of other examples in the report of this apparent lack of concern, but we believe the point has been made.

On page 13 and in Appendix B of the report, the so-called "applicable standards" of South Dakota are given and the report seems to imply that the State has been negligent in the enforcement of these standards. In fact, these criteria, which provide for enhancement of water quality, in accordance with Guideline 1, the old Guideline 1 put out years ago, these criteria can hardly apply until such time as the remedial measures designated in the State's plan of implementation have been completed, including the provision of waste treatment facilities by the Lead-Deadwood Sanitary District by November 1, 1973, as shown on page 49 of the revised and approved South Dakota water quality standards, copies of which are before the conferees.

It should also be noted for the record that in Mr. Rouse's presentation I believe he related some levels of certain materials to these standards for Whitewood Creek, and obviously there are no standards for Whitewood Creek.

It should be noted for the record that the Homestake Mining Company and the cities of Lead and Deadwood were directed to provide treatment facilities, in accordance with a schedule of compliance, by the South Dakota Committee on Water Pollution in 1967. Later an extension of time was granted because of a delay occasioned by the necessity of amending South Dakota law to permit the noncontiguous cities of Lead and Deadwood to form a sanitary district. The standards, including the schedule of compliance noted above, were approved by William D. Ruckelshaus, Administrator of the U. S. Environmental Protection Agency, on June 28, 1971, and by his water quality predecessor, Stewart L. Udall, Secretary of the Interior, on August 7, 1967.

On Pages 1 and 2 of the report, it seems to be inferred that the study upon which the report is based was undertaken to implement the request of Governor Richard F. Kneip for an enforcement conference to consider the occurrence, distribution and significance of cyanide, mercury, and other metals pollution in western South Dakota, though actually Governor Kneip requested that the problem of actual or potential mercury toxicity to humans be given primary consideration. The full text of the Governor's request is included in the report as Appendix A.

The fact is, the decision to undertake the study reported in the black cover was made at a meeting of Federal and State officials and others at the Oahe Dam Powerhouse near Pierre on April 6, 1971, some 17 days before the Governor made his request and almost three months before Mr. Ruckelshaus agreed to hold this conference. A number of participants in that April meeting are here today, and the report on a portion of the study, presented at this conference earlier by Dr. Thomas Hassler, relates to the development at that time of a cooperative

Federal-State plan for a preliminary study to further explore the incidence of mercury in fish.

In paragraph 2 of page 15 of the report, the statement is made that "By August 1970, no progress had been made in the Homestake waste-treatment practices and the tailings solids were still being discharged to Whitewood Creek. The discharges were found to contain significant quantities of mercury." We certainly agree that tailings were still being discharged, but we emphatically disagree with the statement that no progress had been made. At that time,the most recent of three separate studies by three different consulting engineering firms was under way. The first of these was conducted in 1964. In fact, the Region VII EPA representative who collected the samples in which mercury was found, Mr. Dale Parke, was in the area at our invitation for the primary purpose of observing and assisting in a pilot plant study of the feasibility of a tailings pond for treatment of the combined tailings-domestic sewage wastes.

Further on in the report, on page 28, the statement is made that arsenic levels in the Cheyenne River downstream from the Belle Fourche were four times the rejection level for use as a public water supply. We think the record should show that no part of the Cheyenne River in South Dakota is classified for use as a domestic water supply. In fact, to the best of our knowledge, no such use is made of the river anywhere either in South Dakota or in Wyoming. The only assigned beneficial uses in Wyoming are "agriculture" and "wildlife propagation."

Elsewhere in the report, as on page 18 and on page 27, the toxicity of arsenic is discussed, and throughout the report a good deal of emphasis is placed on the occurrence of this element. The arsenic is said to result from the oxidation of the non-toxic mineral arsenopyrite present in the Homestate wastes. However, since the samples in which the arsenic was determined were preserved with concentrated nitric acid, we wonder whether the values reported reflect only naturally occurring free arsenic. Also, since copper is also present in the wastes and EPA's own Duluth National Water Quality Laboratory is attempting to evaluate the biological implications or potential problems of copper and arsenic associated with suspended or settleable solids or sediments of any nature, we wonder whether the emphasis on arsenic may not be premature. And we have appended and made a part of our presentation "Items for Fishery Scientists," October 1971.

I would like to request of the Chair that that be made part of the record as well.

MR. STEIN: That will be included in the record.

(The above-mentioned document follows:)

October, 1971

TEMS for Fishery Scientists

from the SPORT FISHING INSTITUTE

719 - 13th Street, N.W., (Suite 503) • Washington, D.C. 20005

Robert G. Martin, Assistant Executive Vice President

OCT 1971

CAN YOU HELP -- The National Water Quality Laboratory is attempting to evaluate the biological implications or potential problems of copper and arsenic associated with suspended or setteable solids or sediment of any nature.It is felt that, as a result of extensive use of compounds of these elements by various people and agencies as solutions to assorted aquatic problems, there should be much information other than is readily available to literature retrieval. Data, reports, or opinions concerning the effects on aquatic life of copper and arsenic, when associated with organic or inorganic deposits, would be appreciated. Please forward such information to either Mrs. Mary Lewis or Dr. William A. Brungs, National Water Quality Laboratory, Environmental Protection Agency, 6201 Congdon Boulevard, Duluth, Minnesota 55804.

CAREER OPPORTUNITIES -- Colorado State University -- Assistant or Associate Professor of Fishery Biology -- One position. The position entails responsibility for teaching fish ecology at senior and graduate level, ichthyology, and populations dynamics. One course each quarter. Serve as major advisor for a limited number of graduate students and a group of undergraduates with participation in student seminars and organizational meetings. Requires Ph.D. degree with broad base in biological sciences and competence in fishery science, aquatic ecology, and population dynamics. Must have at least five years teaching experience, with demonstrated ability to perform quality research resulting in major publications in technical journals, and experience in obtaining research grants. Salary (nine-month appointment) competitive and dependent on experience and qualifications. Summer salary depends on summer teaching assignments and research projects. Applicants should forward inquiries with curriculum vitae to Dr. Gustav A. Swanson, Head, or Dr. W. Harry Everhart, Chairman, Fishery Major, Department of Fisheries and Wildlife Biology, Forestry Building, Colorado State University, Fort Collins, Colorado 80521.

Connecticut -- Farmington River Watershed Association -- Executive Director -- One position -- The Executive Director is the principle administrative executive of a 1,500-member watershed association founded in 1953 to preserve the ecological health of the Farmington River and its 600 square miles of watershed. The incumbent will be primarily responsible for identifying emerging environmental issues at an early date, recommending programs for meeting the issues, and initiating actions within guidelines established by the Board of Directors. Requires professional training in ecology, forestry, geology, biology, or related natural sciences, preferably with an M.S. degree and substantial field experience in natural resources work. Must have proven ability and experience with administrative duties and coordination of multiple projects plus the ability to speak effectively before citizens and public officials alike. Salary range between $12,000 and $18,000 per year. Interested applicants should submit resume and earning history to Hiram P. Maxim, President, Farmington River Watershed Association, 195 West Main Street, Avon, Conn. 06001.

Maryland -- Natural Resources Planner -- One position -- The incumbent will serve on the staff of the Planning Division of the Maryland Department of Natural Resources and will be responsible for developing and integrating fish and

MR. ALLUM: There are other items of inconsistencies that could be cited, and we will be glad to discuss them with the authors of the report, under the proper circumstances, of course. (Laughter.) However, in the interests of time, we will now turn our attention to the recommendations presented on pages 6 and 7 of the report.

We concur in Recommendation No. 1 that the Lead-Deadwood Sanitary District proposed treatment facility at Centennial Valley be constructed and in operation by November 1973 if that is humanly possible now following the delays beyond the control of the district or the South Dakota Committee on Water Pollution. We note that preliminary plans and specifications were approved by our department on March 31, 1970, and that a grant application for the project was submitted to EPA over six months ago. To the best of our knowledge, no action has been taken on the grant application because of the pending environmental impact statement, which we understand is reposing in Washington, D. C., awaiting distribution to the other governmental agencies which must review and act upon it.

Since the answer to the problem of Homestake wastes will be provided by the permanent facilities proposed by the Lead-Deadwood Sanitary District, we suggest that more effort be applied to expediting the environmental impact statement and processing the grant application so that the project, already set back about a year, can be completed without further delay. As noted on page 34 of the report, "...the overall environmental impact will be less than the existing situation..The proposed sanitary district project will be a marked improvement over the existing situation." This seems to us to be more or less of an impact statement, I guess.

We do not concur in Recommendation No. 2 regarding the construction and operation of an interim tailings pond. In the first place, we seriously question the philosophy of removing wastes from a stream system that has been contaminated for 93 years and placing such wastes in another as yet uncontaminated stream system where there can be no guarantee at all that the wastes can be contained and kept out of the Cheyenne system in any case.

Now, in addition to the question as to the legality of the diversion of Whitewood Creek under South Dakota's water laws, such a diversion would be a violation of South Dakota's water quality standards. Crow Creek, to which diversion is proposed, is an intermittent stream and all discharges to intermittent streams, among other requirements, shall not exceed 30 milligrams per liter of suspenced solids based on 24-hour composited samples, this information given on page 19 of "Water

Quality Standards for the Surface Waters of South Dakota". We wonder whether the Environmental Protection Agency really wants the State of South Dakota to agree to the violation of its own water quality standards.

Further, in Recommendation 2, it is recommended that the Homestake Mining Company be cited under the River and Harbor Act of 1899 if the interim facility is not completed and operating by July 1, 1972. Aside from what appears to be a near-impossible deadline, since the River and Harbor Act relates to discharges to navigable waters and their tributaries, are we to assume that the Homestake Mining Company will not be cited for discharges to what is an obvious tributary? Also,since State certification of such discharges is necessary before a Corps of Engineers permit can be granted, are we to be required to provide such certification whether we can do so in good conscience or not?

We concur in Recommendation No. 3, but we have some question as to how the existing stream deposits may be contained and this was discussed earlier this morning following Mr. Rouse's presentation. We question, for example, if we utilize riprap do we riprap that portion which would be contained within 30 second feet of flow or do we go for this maximum flow of 5,000 which is known to have occurred there? These are some questions and as was indicated, the problem is being studied.

Perhaps containment methods have been utilized elsewhere in the United States where mercury dischargers have been cited. If so, these methods can be brought to the attention of the conferees for their consideration.

We concur in Recommendation No. 4 regarding testing of wells for arsenic.

Recommendation No. 5 has been discussed previously by Dr. Hayes, and we concur in his objections for the same reasons.

We concur in Recommendation No. 6 and will comply as far as our budget and the budgets of other State agencies will permit. We are somewhat puzzled about this recommendation, however, since on page 20 of the report it is stated that "These findings indicate that previous mining sites are not significant mercury pollution sources," and it is only speculated that "mill tailings located west of Lead could be a source of water quality degradation," on page 11.

We concur in Recommendation No. 7, and water quality standards will be established for Whitewood Creek and Deadwood Creek as soon as beneficial uses for these intrastate streams can be established following completion of the Lead-Deadwood Sanitary District treatment facilities. We call your attention to the fact that an implementation plan for abatement of existing pollution was adopted in 1967, and consequently we have already concurred with a portion of Recommendation No. 7.

In regard to the recommendations on the last page of the report presented by Dr. Hassler entitled "Preliminary Investigation of the Mercury Content in Fish, Sediment and Water in Lake Oahe, South Dakota," we concur in Recommendations No. 1 and No. 3 without reservation. However, we do not concur in Recommendation No. 2 for the reasons previously discussed by Dr. Hayes.

Now at this point I will have to do a little ad libbing. We had not received, at the time we left the office, the final copy of the report prepared by Dr. Lammering. We had been provided with draft copies and we see no great changes between the draft and the final copy except the final was quite a bit thinner than the draft copy was. And we would concur with recommendations as presented by Dr. Lammering except for No. 2, I think, where the question is whether these tailings piles will be sealed and at some X date removed or--I believe that is the one, No. 2.

We would recommend that initial consideration be given right away to removal of those sand tailings and placing them back in the mine rather than some interim measure of trying to seal those things and then at some later time--

MR. STEIN: I meant to ask that question. How far is that mine from the sand--

MR. ALLUM: Well, they have trucks coming in and they are going back empty, so it doesn't make much difference. (Laughter.)

MR. STEIN: O. K.

MR. ALLUM: I thank you for your attention, gentlemen.

MR. STEIN: Thank you.

Are there any comments or questions?

MR. DICKSTEIN: Yes. There were some serious accusations made about the information in the black report, and I believe that our authors are in a position to defend their original opinions.

I would like to turn this over to the authors for their comments on Mr. Allum's statement.

MR. ALLUM: Did you have anybody else that you want to stick in here, Doc, before I get back to the rostrum?

MR. STEIN: Do you really feel you have--

MR. ALLUM: We would be glad to discuss it with them directly.

MR. STEIN: Let me say, I think a good portion of the comments you made speak for themselves. Now, if you think anything can be resolved by engaging in this, fine, the floor is open. If you don't--

MR. WARNER: Personally I feel that the conferees have a good grasp of what is in the report, and they can come to their own conclusions.

MR. STEIN: I think the issues here are squarely joined.

Is there any comment? Because I don't want to cut this off in any way.

I think you have joined the issues, and we can resolve this among the conferees when we deliberate.

MR. GRIMES: If there is any element in which the people preparing these reports can reach agreement among themselves, it would be very helpful to the conferees. Now, whether they do it now or in some private session, I would prefer that they get together and get a job done if they can.

MR. STEIN: I would hope that we could get this resolved by tomorrow. Probably you can get together with Mr. Allum. As a matter of fact--let me go off the record here.

(Off the record.)

MR. STEIN: Let's go back on the record.

MR. GRIMES: Again off the record.

(Off the record.)

MR. STEIN: Go back on the record.

MR. ALLUM: May I make one comment?

It was our impresssion in reading the report that it tended to suggest that the report was prepared on the basis of a study resulting from the Governor's request. Now, we recognize that you people understand that this is not the case, but the public doesn't understand this sort of thing.

MR. STEIN: Right. And another thing, I think we get this with the State. Let me make this just generally for the statement.

I think the problem we have with every State is the notion that you stated two or three times in your statement--the report contained an implication that the State wasn't doing its job. I don't think this is the case. I don't think this is the case at all, because again let me try to point out what are the alternatives we have.

We can go into a 180-day notice for violation of standards or against an industry we can go in for a violation of the 1899 Act. Those are Federal operations and we proceed against one of your constituents, and the State isn't involved.

When we have a conference of this kind, this is a cooperative venture, and I think your Governor pointed that out very clearly. We are cooperating with you precisely because we think you are doing your job. And I don't think there is any implication in here, as I heard this report, of anyone not doing the job.

The question here, and I think we have heard Dr. Hayes and Mr. Grimes and the other people raise these questions, these are the kinds of questions that we are grappling with and we need all the help we can get. I wish to the devil we could give you easy answers or certain answers to the questions.

But the reason we are here is we know we have experience in dealing with these questions throughout the country. We have to rely on your experience in your particular State where you are dealing with these day-to-day answers. The only reason I have learned anything about this and your allied problems that we have is by contact with the various State administrators that are grappling with the problem. And we don't come out here with any magic formula to solve any problem in South Dakota, and I think we would be exceedingly foolish if we came up with any presentation that we didn't thoroughly discuss with you first the way we are doing here.

What we do have is access to experience based on a countrywide jurisdiction, and I have been in these cases as our group has many, many times. We do have access to people like the Fish & Wildlife people and the Food and Drug people, and we can get presentations and excellent advice from them, as I think in points of view I think we have here, and we are also able to throw resources into a problem to investigate something or develop a report.

But to think that we have the answers or that we are implying a criticism of the State I think is wrong. We are here to sit down and work with you on the basis. And I do think that the substantive comments and questions that the State made here have been very, very, very helpful indeed.

And I will tell you this personally, I think Dr. Hayes and the representatives of the staff and all of you have evidently looked at this problem long and hard and have a very sophisticated approach to it. I don't think there is any question about that. And with that I think we should, in the analogy, set this crate of eggs to rest without breaking them. We are all going to have to put everything we have in it and try to come up with a solution.

And put it this way, maybe halfway through this I can dimly see the light in the end of the tunnel. But I don't think until we have heard from the industry and some of the others that we really can nail this down and know how we are going to come out. And this isn't meant as a criticism of anyone at all.

Are there any other comments or questions?

If not, I think this should conclude us for the day and we will stand recessed until 9:30 tomorrow morning.

(Whereupon, at 5 o'clock an adjournment was taken until 9:30 o'clock, Wednesday, October 20, 1971.)

MORNING SESSION

WEDNESDAY, OCTOBER 20, 1971

(9:30 o'clock)

MR. STEIN: Let's reconvene.

We will continue with South Dakota's presentation. I understand yesterday I said North Dakota several times. The reporter will change that to South Dakota wherever it appears.

Dr. Hayes.

DR. HAYES: Thank you, Mr. Chairman.

I would like to call first this morning the Lead-Deadwood Sanitary District. Mr. Floyd Matthew, I think, will make the presentation for them. Mr. Lawrence Jeffries is their president.

Do you want to make that, Floyd?

FLOYD L. MATTHEW, PROJECT ENGINEER
BRADY ENGINEERING COMPANY
SPEARFISH, SOUTH DAKOTA

MR. MATTHEW: I am going to make two statements this morning. The first one will be concerned with the written statement you have in front of you and I am asking that that be entered into the transcript as written.

MR. STEIN: Without objection, that will be done.

(The above-mentioned statement follows:)

CONFERENCE ON PUBLIC HEALTH PROBLEMS
DUE TO MERCURY IN WESTERN SOUTH DAKOTA
October 19,20,21, 1971.
Rapid City, South Dakota

STATEMENT ON LEAD-DEADWOOD SANITARY DISTRICT PROPOSED TREATMENT FACILITY

Prepared and Presented by:
Floyd L. Matthew, Project Engineer
Brady Engineering Company
Spearfish, South Dakota

I. PURPOSE

The purpose of this statement is to present general data on the proposed Lead-Deadwood Sanitary District wastewater treatment project and to show the relation of this project to the pollution problems in Whitewood Creek and the Belle Fourche River.

II. LEAD-DEADWOOD SANITARY DISTRICT WASTEWATER CHARACTERISTICS

A. Domestic Wastes

All domestic wastewaters from Lead and Deadwood are presently discharged to Whitewood Creek without treatment. Domestic wastewaters are diluted to about one-fourth the strength of normal domestic wastes by ground water. All storm drainage from Lead and some of the storm drainage from Deadwood is carried to Whitewood Creek through the combined sanitary-storm water sewer systems.

Polluting materials contained in the domestic wastewaters include bacteria, organic materials, suspended solids, phosphates and nitrates.

B. Industrial Wastes

Industrial wastes from Homestake Gold Mine are presently discharged directly to Gold Run Creek below Lead and to Whitewood Creek in Deadwood. The extremely large quantity of waste rock discharged as sand and slime after gold is extracted by cyanide solutions comprises the most important industrial waste pollution problem. Cyanides and trace quantities of several metals are also contained in the industrial waste flow and must be considered in the selection of treatment facilities.

C. General

Design flows for the proposed waste treatment facility are presented in Table I, below. Domestic and industrial waste characteristics are available from Brady Engineering Company on request.

TABLE I SUMMARY OF DESIGN FLOWS FOR THE LEAD-DEADWOOD SANITARY DISTRICT

Source	Average Flow MGD	Peak Flow MGD
Lead	1.1	2.0
Deadwood	0.8	1.4
Infiltration & Storm	4.6	47.5
Industrial	5.6	12.4
Total	12.1	63.3

III. EFFLUENT QUALITY REQUIREMENTS

A. Effluent Standards

Effluent standards for treatment facilities treating combined domestic-industrial wastes from the Lead-Deadwood Sanitary District have been established by the South Dakota State Health Department as follows:

Parameter	Maximum Concentration Permitted
BOD_5	30 mg/l average 60 mg/l peak
Suspended Solids	30 mg/l average 60 mg/l peak
Mercury	0

B. Stream Standards

Proposed treatment facilities for the Lead-Deadwood Sanitary District must be designed to meet the following stream standards established by the SDSHD for the Belle Fourche River below the confluence of Whitewood Creek:

Parameter	Maximum Concentration Permitted
Cyanides (Free)	0.02 mg/l (CN^-)
Dissolved Oxygen	<5.0 mg/l
Hydrogen Sulfide	1.0 mg/l
Iron (Total)	0.2 mg/l
pH	6.3 - 9.0
pH change	0.5
Suspended Solids	90 mg/l
Temperature	90° F
Temperature Change	5° F
Turbidity	10 j.c.u.
Fecal Coliform	1,000/100 ml mo. average 2,000/100 ml maximum - summer

Alkalinity	750 mg/l ($CaCO_3$)
Total Dissolved Solids	700 to 1,500 mg/l
Electrical Conductivity	1,000 to 2,500 mmhoes/cm @ 25° C
Nitrates	50 mg/l as NO_3
Sodium Adsorption Ratio	10 to 26
Soluble Sodium Percentage	30 to 70
Toxic Materials	$<$0.1 x 96 hr. MTL for short residuals or 0.01 x 96 hr. MTL for 30-day plus residuals
Taste and Odor Producing Substances	Not to produce tastes and odors in aquatic life.

IV. DESIGN PROBLEMS

A. Hydraulics

Storm flows from Lead and Deadwood produce very high flow rates that must be accommodated by the proposed piping and treatment facilities. Ground water infiltration produces a domestic wastewater which is too dilute to treat in conventional trickling filter or activated sludge mechanical treatment plants. Separation of storm and sanitary sewers is not practical because of engineering and cost restraints.

B. Pollution Parameters

The proposed treatment unit(s) must be capable of reliably removing bacteria, organic materials, cyanides, heavy metals and solids as required to meet the effluent and stream standards outlined in Section III. In addition, the facilities must be designed to store or dispose of approximately 3,000 tons of solids per day for a design period of 20 years.

V. PROPOSED TREATMENT

A. Collection

On the basis of studies conducted by Brady Engineering Company during 1970, it is proposed to collect Lead, Deadwood and Homestake waste flows and route them through an 8 mile pipeline ranging from 33 to 48 inches in diameter. The pipeline follows Gold Run Creek from Lead to Pluma, then follows Whitewood Creek through Deadwood and discharges to Centennial Prairie located on the divide between Polo Creek and Whitewood Creek drainages. The effluent will be returned to Whitewood Creek.

B. Treatment

The proposed storage-treatment facility consists of a reservoir on Centennial Prairie. Field, laboratory and pilot plant studies conducted by the South Dakota State Health Department, Homestake Gold

Mining Company and Brady Engineering Company show that the removal of solids, bacteria and organics is effectively accomplished by holding the combined domestic-industrial wastes in an impoundment for a 3 to 7 day period. A pilot plant study conducted in the summer of 1970 on combined domestic and industrial wastewater flows verified that the effluent from a holding facility providing a 7 day detention would reliably meet the effluent and stream standards presented in Section III, above. Heavy metals are associated with the solids and settle to the bottom of the treatment unit. Mercury concentrations were reduced to zero in the pilot plant. Cyanide reacts with sulfides released from pyrrohite in the ore and is converted to relatively nontoxic thiosulfate and iron cyanides. Brook trout lived for 8 days in the effluent from the pilot plant when the detention period was 7 days. This indicates that toxic substances are reduced to levels which will meet the established stream standards.

The proposed facility will provide an initial detention period of over 300 days which allows a treatment duration safety factor of 40 over that shown to be required by lab and pilot plant studies. This safety factor will be reduced as the treatment-storage unit fills, but at no time during the life of the proposed facility will the detention be less than 7 days. The consulting engineers, offficals of the LDSD and officials of the South Dakota State Health Department are confident that the proposed treatment facility will eliminate the existing pollution problems on Whitewood Creek and the Belle Fourche River.

VI. SCHEDULES

The original project schedule called for completion of the design phase by January 1, 1972, and completion of the construction phase by October 31, 1973. However, this schedule was contingent upon receiving approval of the preliminary report from the Environmental Protection Agency by July 1, 1971. Approval has not been granted to date and it is doubtful whether approval will be granted for several months. Consequently, the design and construction schedule is now indefinite pending action by the Environmental Protection Agency.

Due to problems with winter access, it will not be possible to complete field work this fall to allow the design phase to proceed during the winter months. Consequently, it does not appear that the design and review phase will be completed until late in 1972 or early in 1973. In view of the short construction season, we wish to allow the contractors two summers to complete the project. This means that the fall of 1974 is probably the earliest possible date for completion of construction.

In summary, the cities of Lead and Deadwood and officials of Homestake Mining Company have taken positive steps to provide an efficient, reliable wastewater treatment system that will eliminate the pollution in Whitewood Creek and the Belle Fourche River. As soon as EPA approval is granted, the project schedule will be resumed.

F. L. Matthew

MR. MATTHEW: I will make the first statement just as the consulting engineer for the Lead-Deadwood Sanitary District. Larry Jeffries, the Chairman of the Board, was not able to come down this morning.

Then I am going to cut it off and make a statement as Floyd Matthew, citizen, an individual who has been up to his neck in sewage in South Dakota for the last 10 years. And that statement will be an oral statement. I did not have time to present it. I did want to make my statement in view of what was said yesterday, so if you will bear with me during that second period there may be some warm turbulence floating here, but I do have a few things to say.

In the first place, in the interest of conservation of time, let's just get right through this thing. This statement outlines the project that is proposed to be constructed by the Lead-Deadwood Sanitary District to correct the problem we are here to talk about, pollution of Whitewood Creek.

The problem boils down to this. We have got combined domestic-industrial wastewaters that have to come out of that area. If you look at the finance restraints, it is impossible for the cities to go it alone. Now, they have a very dilute waste. We have to handle both the storm and sanitary sewage because they have a combined sewer system, it is just practically physically, from an engineering standpoint, impossible to go in and separate those sewers, so we do have to handle a large volume of sewage during storm flow or high runoff periods. So these cities cannot go without Homestake. We find that this is a financial impossibility.

The sewage is so dilute because of groundwater infiltration that we cannot treat it in conventional treatment facilities, so we could not put the sewage from the cities into a conventional treatment facility and bypass during storm flow periods. This is again impractical because there is about a 5 to 1 dilution because of groundwater infiltration. They tapped in just about every spring in that area as they built Lead and Deadwood. Nobody even knows where the sewers are, so it is pretty tough to get in there and separate them.

So when we sat down to correct the problem we had four things to concern ourselves with and we had to remove in order to meet the stream standards. One of those is solids, and this is an industrial waste problem and this is the major constituent of the waste as far as the design is concerned, 3,000 tons, approximately, a day of finely-ground inert rock that is discharged right now to Whitewood Creek. The treatment facility must be able to remove that material, and as we said yesterday, 99.7 percent of it must be removed on a reliable basis and store it in a reliable manner. That is the big problem.

Along with that we have the organic materials, then, from Lead and Deadwood that have to be handled and we have the bacterial pollution. Now, this wasn't alluded to in the report when you considered the problems up there with domestic-industrial waste. In reality, the bacterial pollution problem is the one that lends itself most to the public health problem on the stream, and I think it should have been included in the report as one of the major constituents of the domestic waste. The organic materials are not a serious problem. So we have got to take out bacteria, we have got to take out large quantities of solids, and we have got to take out organic materials from Lead and Deadwood plus the toxic materials, and this includes cyanide and possible trace quantities of heavy metals, and so on.

Well, you just don't run this thing into a tank and back out again and take out all these materials. Over the last 10 years there have been several studies conducted. As a professor out here at the School of Mines I had several research projects associated with the treatment of this waste. The South Dakota State Health Department has done work on it, Homestake has hired two indépendent consultants, plus their own staff which does a great deal of work, to develop a treatment method that would reliably remove these materials and the combined waste flow, you see.

And we ended up with just a very simple, very reliable device that is so simple, in fact, that we are having trouble selling it. It is a detention dam that will be constructed down on Centennial prairie. We are going to put in 8 miles of pipe that will range in size from 33 to 48 inches. We will be able to take all of the flow, then, from Homestake Gold Mining Company, all of the flow from Lead and Deadwood, 8 miles of pipe, and go down there about 3 miles below Deadwood to Centennial prairie. And we built a dam that has 290 surface acres; it will be 90 feet deep. And we fill the dam up; we provide up to 350 days detention, and when the overflow goes out, the cyanide has been removed. The heavy metals are associated with the solids there on the bottom; we store the solids there for a period of 20 years. That is what we propose to do with the waste.

The effluent comes back into Whitewood Creek after treatment. We do take it out of the Whitewood Creek drainage into Polo Creek drainage and back into Whitewood Creek. The site appears to be very satisfactory. In fact, the further we get into the design the happier we are with the site and the outfall pipeline alignment. Everything seems to be working out very well from the engineering standpoint.

I think that there is enough information contained in the written report here now that you can pick up the details. Let me discuss now the schedule that was originally proposed and how that influences this conference.

The original schedule called for approval of the construction grant and the preliminary report by July 1, 1971, this year. There was opposition to the site location at Centennial prairie and an in-depth environmental assessment statement is being prepared. Nobody seems to know where that statement is at the present time. We do not have approval for the project yet. It does not look like we will get approval any earlier than January 1 because of the procedures that have to be followed in handling this environmental assessment statement.

So this puts the project schedule back about a year, because, you see, we need two construction seasons because of the area and the topography and the size and the scope of the project. We want to give the contractor two construction seasons. Well, we are not able now to collect the ground data to complete the design as we had originally intended by January 1 of 1972. You see, we planned to be in the field this year and then during the winter completing the design, getting through the review and approval and letting the contract next spring. Now we are going to have to be in the field collecting our grounds proofs next spring. This means it will be in the design and review period during next year's construction season and this puts the November 1, 1973, deadline in jeopardy. The damage has been done, the delay is there, we have to face it.

Now, we can build this thing possibly in one year, but it would have to be a crash program and we would, I am sure, have an inferior project, and I cannot recommend it as a consulting engineer to my clients that we go into a crash program and try to meet this deadline. It isn't a practical thing to do from the engineering standpoint.

That will end my statement regarding the prepared paper. Are there any questions regarding the scope or intent of this project? I will be happy to answer them at this time.

MR. HODGINS: I have a question. Do I understand that it is possible probably to have a contract let by that November 1973 date?

MR. MATTHEW: Oh, yes, we can have it under construction by then. It depends entirely on when we get approval, of course, from the Environmental Protection Agency now, and then after approval we have to go through the financing phase. This is the one that Larry Jeffries is so concerned about right now.

And this, by the way, is a good point to make, I think, and will need a good solid support from all individual groups and agencies if we are going to pass this bond issue, and that is the next hurdle. Because of the controversy that has developed over the Centennial prairie site, the delay that has been exhibited here now because of the environmental impact statement, a great deal of confusion exists in the population in Lead-Deadwood. And we are going to have to cope with that confusion,and I am afraid that we may have trouble financing the project.

By the way, this delay is costing Lead-Deadwood Sanitary District about $1,300 a day in inflation costs alone, so whoever has got that thing sitting on their desk in Washington, we would certainly appreciate it if you would shake that thing out of the tree.

Are there any other questions on either the scope or the intent of the project?

We did run a pilot plant study in the summer of 1970, I discussed that in the report, in the paper, to verify the theoretical conclusion that the cyanide would react with the sulfides and be removed. At the same time we ran mercury tests, we removed essentially 100 percent of the mercury with the proposed facility, the bacterial reductions were well within the standards, the organic reductions were excellent, and that was with 7 days detention. The facility we are proposing to build will have 350 days detention at the beginning and this will gradually, of course, be reduced as the pond fills, but at no time will we ever approach the 7-day detention period that we used in the pilot plant study.

In that study we used fish and we used bioassay test techniques, because the chemistry is so complex that no one could predict what is going to happen in regard to toxicity of these wastes when they get all combined and put together--I don't care if you are talking about mercury, cyanide, arsenic, or what. The waste is too complex to use an analytical theoretical approach.

So we put fish in the effluent and we killed the fish with three days detention; with five days detention they started living; at seven days we kept brook trout alive for eight days. We felt that this was a satisfactory indication that the toxic levels were low enough that we could accept this treatment method.

South Dakota State Health Department has approved the method. I am confident it will work. The Lead-Deadwood Sanitary District is confident it will work. Homestake Gold Mining Company officials are confident that it will work. All we need is the go-ahead from EPA right now, and we will get this problem solved.

MR. STEIN: Go on.

MR. DICKSTEIN: Just out of curiosity, Mr. Matthew, you mentioned earlier the microbiological problem. Did you do bacteria counts on the effluent from the plant?

MR. MATTHEW: Yes, we did, reduced the count, I think it was, 10--the MPN count was 10 in the effluent at three days detention, so we figured--

MR. DICKSTEIN: Fine. So it looks like we are in pretty good shape there?

MR. MATTHEW: Yes.

MR. STEIN: Again this may not help your problem, but what you are saying about these dilute wastes is not unique to this area. As a matter of fact, one of my colleagues here, when he heard you, said, "What's new?" This is what we face all the time. And as a matter of fact, I think you are fortunately located in a place where you have the space to go to this detention pond technique.

For example, St. Louis has the same problem with sewers, old sewers, infiltration, springs, just couldn't--they have to take this dilute waste and build a mammoth plant and treat it and then get rid of the effluent right away. So I do think, in a sense, that the sanitary district and the people here, while recognizing that they have a problem of infiltration and sewers, unknown sewers and springs coming in and the dilute waste, should recognize that this is not a unique problem but you have the tremendous advantage of being able to come up with the kind of solution you have.

Now, one other thing, I raise this question because we have got two problems. If we have a problem with the deadline, then that begins to add to the problem of the proposal for interim treatment somewhere else. The point is if the work is done and the contracts are let--and I know you have expressed your views of pushing this forward--but don't you think it would be possible to have an accelerated program if what we are doing is essentially building a tunnel, interceptors and a big hole, right?

MR. MATTHEW: That is what it amounts to, just a big holding facility.

MR. STEIN: O. K. What I am saying, if that is the kind of construction, once you people have done your engineering you are pretty well certain, it seems to me, that the construction can move apace on this. This isn't a question of installing or fooling with fancy panels of equipment and valves and stuff of that kind that we may have on other types of construction.

MR. MATTHEW: I--

MR. STEIN: Let me explain the purpose of the question. The purpose is to see what the chances are of meeting this deadline, because if we are not going to meet the deadline, I think we are going to have to recognize that fact when we consider the question of the proposal for interim treatment.

MR. MATTHEW: That is true. And of course that is the primary decision you people are going to have to make.

MR. STEIN: That is right.

MR. MATTHEW: In the first place, we are talking about a year's delay. The interim treatment will have minimum effect, I think, on the water quality in the stream. I think that the--I am going to discuss this in more detail a little bit later on here too.

But in answer to your question, we can't make an answer as consulting engineers regarding schedules until we study the problem, because it is not quite as simple a device as you are envisioning here. The problem is we have to handle large quantities of solids. This may require pumps, dosing siphons, valves, a few you don't envision, you see, and that design is very critical. We still have to do some studying, in fact, at this point that we haven't initiated because we are waiting for this approval.

I don't think that we could get interim treatment facilities provided any earlier than November 1 of 1973. I think that we are talking about design and begin construction this next summer and then finish up construction the following summer, which is the summer of 1973. Sometime late in the fall of 1973 we could possibly get the dam constructed, but I think that we would want at least two construction seasons or part of one and a full one at least.

So it won't be a quick solution, but we could possibly have some facilities operational by November 1 of 1973.

MR. STEIN: Is it an earthen dam?

MR. MATTHEW: This is an earthen dam.

MR. STEIN: All right.

MR. MATTHEW: It is a little different construction from the tailings dam you ordinarily envision, and we did this and Homestake Gold Mining Company is willing to put up the extra money along with the Lead-Deadwood Sanitary District because of the aesthetic factors involved. By putting up an earth-filled dam and filling it you won't see the slimes. If we built the dam out of the slimes, then you have got the sand separation units and sandy dikes and blowing sand and things like that.

MR. STEIN: I understand, and I think your points are well taken. I am sure you put your finger on what is going to be the critical point, i.e., the place or the entry where you get all of these solids coming in. Obviously you are going to want distribution of them when they get into the pilot.

MR. MATTHEW: Like I say, we can go into a crash construction program. We would have to talk to some people and evaluate this thing, but I have always talked two construction seasons and I think that is the only practical approach.

MR. STEIN: Were you here yesterday when we heard the suggestion?

MR. MATTHEW: Yes.

MR. STEIN: Let me just pose the question for the conferees. I think we have one question if we are going to finish this facility in 1973, with the consideration that we go to the interim proposal and that it would operate for just one year. But if there are a lot of questions and we don't have a date certain for the completion of the sanitary district project, then it may be that we would be going two or three years without substantial abatement when the project is completed. I think this is what we have to consider.

DR. HAYES: Mr. Chairman, I would assume that one of the functions of the conference or at least one of the spinoffs might be that if we as conferees agree that these things should be done that perhaps it will assist in getting the statement made or circulated. You realize these environmental impact statements have to go around to a number of agencies, not just the Envrionmental Protection Agency, but if in fact we haven't been able to get it out of the pigeonhole--and there may be reasons for that which I understand too--but if this will help do that, then perhaps we will get things under way with a full head of steam here today.

MR. STEIN: That might be. I don't want to make this suggestion for the conferees to prejudge it, but I think if we have a schedule which we indicate has to be met, that might be helpful in enabling us to do it. We can always ask why.

DR. HAYES: I agree, I think it works both ways.

MR. STEIN: Right.

DR. HAYES: Everybody has to follow the schedule then.

MR. STEIN: That is right, everybody.

Now, again I don't want to do this, because I know you people have been very polite about these impact statements, and I hate to do this by implication because this indicates that the Federal Government has the ball on its side of the net. But I might add that we have been a long time awaiting formation of the sanitary district and a long time with the notion that Homestake was going to join with the sanitary district for the solution. So while you have the luxury now of coming around and saying the ball might be on the Federal side of the net, we were waiting for many years for it to come over. (Laughter.)

MR. HODGINS: I have a question, Floyd. I wasn't here yesterday to hear the presentation, but does this interim proposal include the treatment of the waste from Lead and Deadwood or is it just the Homestake wastes?

MR. MATTHEW: Actually, you see, I am not involved in this interim treatment facility. Homestake Gold Mining Company has been studying the interim treatment facility.

MR. HODGINS: Only Homestake?

MR. STEIN: Yes.

FROM THE AUDIENCE: No, no, no.

MR. HODGINS: Then I will ask another question as a political man--

MR. STEIN: Wait. We are mistaken?

MR. WARNER: It is everything.

MR. STEIN: Everything.

MR. MATTHEW: Everything is diverted if Rouse's proposal is followed. However, I don't know how much detention you plan on putting in the facility, and you will have to have 7-day periods of time.

MR. ROUSE: It is initially quite a number of days, well over your seven days, dropping off, of course, to zero at the end of its life.

MR. MATTHEW: I hope that this attitude doesn't prevail that you just expressed here, Mr. Stein, because we realize that that pollution problem has been going on since 1876 and we worked with it a long time. But we are in a situation now that is decidedly different than even three, five years ago. Everything is positive; everybody on the local front is thinking positive, including the officials of Homestake Gold Mining Company all the way down. We have had nothing but a cooperative attitude and cooperative response from Homestake Gold Mining Company and the citizens of Lead and Deadwood so far, and I don't think that we should judge them on the past performance or take anything away from this project. I think we want to proceed from day one right now and approach it positively.

MR. STEIN: By the way, let me indicate to you, I agree with you. I have had many meetings with Homestake. We haven't heard from them here at all yet, but I think they have always taken a very positive attitude every time I have talked to them.

What I was doing was just--I may have heard at least 20 times since this conference began the delays that the Federal Government was having with these impact statements. That is all that remark was directed to, not Homestake or anyone's attitude or the possible feeling, which I sense, on the part of the local people to get the project done.

MR. MATTHEW: Well, and on the other side of the fence, the delay that has been effected because of the environmental impact statement has been an advantageous delay in many cases too. We don't want to overlook that fact.

MR. STEIN: Right.

MR. MATTHEW: That will end my statement as a representative of the Lead-Deadwood Sanitary District and Brady Engineering Company, who are serving as consulting engineer.

Now I would like to speak as Floyd Matthew, Professional Engineer, State of South Dakota, and direct my remarks to the report. And as an individual, of course, I don't have a boss to satisfy or anything, so I can say pretty much what I want to up here for a while until Mr. Stein cuts me off.

I will try to be brief, but I think that there are some very important considerations that should be made here today, because what we are doing is going to result in the expenditure of a great deal of money. I think the decision that you conferees make in the next day or two here is going to have a marked influence on the economy of the State of South Dakota, on the relationship of the public health people in South Dakota to the citizens, and so let's look at this thing a little bit objectively.

No. 1, I want you to understand why I am so concerned here and why I am making a statement as an individual. I started working on the Whitewood Creek pollution problem in 1962. I went to work for the State Health Department, and I have been working almost continuously on the Whitewood Creek pollution problem since that time. I have a personal vendetta against the Whitewood Creek pollution problem; I want it cleaned up, and everybody else in South Dakota wants that creek cleaned up. I was chief of the Water Pollution Control Section, and Jim Harder will agree that while I was chief of the Water Pollution Control Section I applied as much pressure as I possibly could as a lightweight against Homestake to get the thing done, Lead-Deadwood Sanitary District.

We overcame the first major obstacle in 1965 in the form of the Lead-Deadwood Sanitary District. We formed a governmental unit we could deal with. Then we had some technical obstacles to overcome and Homestake has been working on those trying to figure out a way to treat the wastes and handle it. We have another obstacle and that is the financing. We haven't overcome that obstacle yet.

Then I went to work out here. As I said for six years I was a professor out here at the School of Mines and Technology, and I did a great deal of research just concerning the physical and chemical properties of that waste because I knew that we would get a solution some day and that this might fit.

I have gone the complete gamut. They hired me through Brady Engineering Company and I am serving as project engineer for the project to actually handle it. So for the past two years I spent a great deal of time dealing with this waste, and I think that I do understand the Whitewood Creek pollution problem. There are a lot of other things I don't understand, but I feel that I understand and see the scope of this project.

So that is why I think that it might be worth your time for me to talk about this particular problem and try to put some things in perspective. Some things that I am going to say may sound like I am nitpicking and from a distance it may look like a nit. But from my position the things that I am going to discuss here could become major obstacles in one way or another along the design path, the construction path.

I want to compliment you on the study. I think this is a very in-depth study, very professional study. I think it is kind of like a tree, the tree is basically good. I am going to lop off a few branches here, maybe, or tear off a hunk of leaves so you can see the trunk better, but I do want to preface my remarks by saying that I think that the report itself is good. It is something that we have needed a long time to provide the information for the decision-making process that will follow.

If the people in South Dakota have exhibited a negative attitude, I want to excuse it. We haven't agreed with the findings and the recommendations in the report. However, there is a psychological thing here. We never had a chance to look at it, of course, in the formation phases, and I think you could have overcome an awful lot of this negative approach by overcoming the psychological problem of having had something dumped on you that says you are going to have to do something, you know. And that is one of the reasons that I and others probably approached your report in a negative attitude. However, basically we think the report is good and we are cooperative all the way. I mean my remarks to be objective only.

Now, I think we should critically evaluate the report because the decisions, like I said, that are going to be made on the basis of the findings and the conclusions reached in this report and the recommendations have a far-reaching influence in South Dakota. You people are going to go home, but we are going to stay here and we are going to live with those decisions. Let's get into a few of the things, then, that I want to stress and try to clarify.

No. 1. When you talk about cyanide, mercury and arsenic in this report you are talking about several different things. No. 1, there are two types of cyanides. There are free cyanides and there are combined cyanides. Now, the free cyanide is very toxic; the combined cyanide is very nonreactive. We can't take it out of the treatment facility, and yet you are talking about total cyanide concentrations in this report. The total cyanide concentrations really don't influence the beneficial uses of that stream; it is the free cyanide that influences the beneficial uses.

So the values for cyanide should be looked at in mind that the free cyanide portion is much, much lower. And they ran a standard test. You boil the sample in acid, you convert the nonreactive form of cyanide into a toxic form and then you test it. Well, this isn't all toxic cyanide that you have measured here.

The same thing is true with mercury. With your test procedure you are extracting some very insoluble nonreactive forms of mercury from that ore, and when you talk about discharging 2-1/2 pounds of mercury a day or 25 pounds or 300 pounds of mercury a day you are not talking about elemental mercury, and the casual reader would gather the impression that you are talking about elemental mercury or methylmercury or toxic mercury. The mercury you are talking about in this report is not all toxic. And I think that that, from the standpoint of the test procedure that was used, is a point that is well worth considering when you evaluate the need for interim treatment.

The same thing is true with arsenic. Now, arsenic is very insoluble. The material that is discharged is arsenopyrite. And yet there is a statement in here, for instance, that the tailings solids include a load of 9.5 tons per day of arsenic, and that is where the casual reader is going to stop. And my God, that sounds like a terrible thing: 9.5 tons of arsenic! The rest of the sentence says in the form of arsenopyrite.

Hell, I'll eat arsenopyrite on my cereal. You see? And the implication here is that we are really polluting that stream with a great deal of arsenic. Well, the arsenic is there, but it is bound up in arsenopyrite and there is as much difference between arsenic and arsenopyrite as there is between sodium metal and sodium chloride, the salt. So let's remember that the method that was used to present this information doesn't really

F. L. Matthew

clearly show the actual picture.

Another thing that I want to bring out about the arsenic problem, and this is very, very important to the overall treatment facility because we haven't concerned ourselves with arsenic in the past, is that they show in this report arsenic concentrations in sediment and water samples of 1,000 μg/l. Now, that is about 1 ppm and, of course, it does violate the water quality standards or your drinking water standards. But the sample was preserved in nitric acid. Arsenic is insoluble unless you put it in a nitric acid solution or some other solvent, but you put it in nitrate acid and you will leach arsenic out of the arsenopyrite. I contend that if you really study this problem you have found arsenopyrite--or arsenic, you have found arsenic in your sample that you sent clear to Athens, Georgia, agitating it all the way in an acid solution, but I don't think that the arsenic is there in free form in the stream.

So I disagree with your findings regarding arsenic. I do not think that we have a public health problem, but I am going to condition that statement because you did find enough that I am going to start some studies of my own. So you did a good thing, but I don't think you reported it correctly, let's put it that way.

These are minor items, maybe, you know, but when you read the report casually, 9.5 tons of arsenic sounds like a hell of a lot of arsenic,and in reality I don't think we have a problem because of arsenic. But I said I don't think; I don't know at this point and I am going to study it further.

Another thing is that the mercury testing that was accomplished was accomplished in two sets. The Denver laboratory accomplished some of it, the Kansas City laboratory accomplished some of it. And if you ever split samples on mercury between two laboratories you will find a wide variation in the results, I don't care which two laboratories you check. What was it, a 20 to 1 differential at least that you found between two laboratories you people used, a 20 to 1 variation. These are commercial laboratories, professional laboratories, they run mercury analyses all the time, a 20 to 1 variation. And yet you will find that they didn't split samples, now, to check to see whether or not the results coming from the two laboratories were actually consistent. I think this has an important bearing on the final conclusions here. Since we are so close to the FDA guideline, small things like this that can create a 10 to 20 percent error do have a bearing on the decision. And I think they should be considered by the conferees.

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If you have the black report, on page 35 they discuss the interim treatment. I have a few things to say in that regard. In the first place, I think that this sets a dangerous precedent. In my experience working with the Public Health Service, the Federal Water Quality Administration, now EPA, and any State regulatory agency, I never before have seen an engineering recommendation complete with cost estimates presented by a government agency that was in the enforcement position. It is a dangerous position. And I think you will find this, Jim, you have placed yourself in a dangerous position by making a recommendation because you went out there and you kicked some rocks, you looked at some topo maps, but when you get right down to it from the engineering standpoint, your solution is not practical.

In the first place, we do not have the grade to transport the solids. At the grade that we have to put that connecting channel in there will definitely deposit the solids, and we are just going to run the waste back in. Because we are running a deposition study right now to design eight miles of pipe and we show we have to have one percent grade in a 48-inch pipe, 33- and 48-inch pipe, depends on the flow and some other factors, to carry these solids. We can't get them over there.

In the second place, as we mentioned yesterday, we violate water quality standards, we violate the State water rights. I am sure you will bear that out, Joe, we are going to have problems there. We have land acquisition problems. And the effect will be minimal; we will contaminate another basin for a minimal effect on the Belle Fourche and the Cheyenne Rivers.

Let's look at that a minute. What will happen if we put in interim treatment for a year, just so that we are jabbing Homestake for not doing anything for almost 100 years down there? That is what interim treatment is really doing, it is jabbing Homestake. They have discontinued the use of mercury. I would say that our problem on mercury contamination in fish flesh cannot get any worse because we have discontinued the use of elemental mercury.And it is possible that we are at the top of the chain and we are going to go down, because the mercury you people are finding in the sediment is mercuric sulfide, insoluble, relatively nonreactive, in fact very nonreactive in that situation, and the methylation procedure may be much slower. So we are not injecting mercury,and I would say if anything the problem should be getting better now for the next few years.

If we put in interim treatment for one year--and will spend a great deal of time and effort, by the way, that will detract from the total project--we are going to confuse the people some more. We are going to have more trouble passing a bond issue and financing this thing if we get this interim treatment thing involved, I am convinced of that. If we do this, put in interim treatment for a year, we aren't going to see any reduction in mercury concentrations in the fish flesh on the Missouri or the Cheyenne Rivers that is measurable. There will be no measurable reduction. I can confidently say that from my experience with testing because it is just too big a system, and it is going to take longer than that to recover.

So in my opinion, to even discuss interim treatment is rather a problem right now, I think especially in view of the fact that on one hand EPA has got the ball on their side of the net, as Mr. Stein said, on the other hand we are rattling the chains of enforcement here. This is incongruous to me,and it doesn't show the cooperative attitude that has been exhibited by the water pollution control agencies in the past.

I would like to discuss that mercury thing now--

MR. STEIN: Mr. Matthew, we are here by the invitation of your Governor.

MR. MATTHEW: That is right, and we are collecting data--

MR. STEIN: Where do you get the rattling? I don't understand you.

MR. MATTHEW: I hear the chains rattling all the time in the halls, Mr. Stein, and I don't think we can ignore them.

MR. STEIN: By the way, you are sure going to hear the chains rattling if we get called in by the Governor. We are a regulatory Agency.

MR. MATTHEW: That is right.

MR. STEIN: And the way our law is set up, when the Governor of a State asks us to come in we are going to come in. But I don't think that is noncooperation.

MR. MATTHEW: I am not referring to that portion of this project as noncooperative. I think you have been very cooperative in the preparation of this report. And as I said, I think it is information that we have needed, and we really appreciate it,

But I think that the noncooperative attitude is this individual who has got an environmental assessment statement sitting on his desk some place in Washington. That is another agency, I realize, but it is still in the Environmental Protection Agency. That is noncooperative because that statement is lost right now. That is how much it means, apparently, to that branch or that division of EPA. That statement is lost.

We can't even find out where it is.

You are in an indefensible position in that regard and I don't want to make a big issue out of it, but it is there. It has held the project up a year, and then on the other hand we are threatened--

MR. STEIN: Mr. Matthew, we are not in an indefensible position and you are making a big issue of it.

MR. MATTHEW: Well, I am because it has delayed the project a year and, as I said, I have a personal vendetta against Whitewood Creek. All I want to do is get the problem corrected,and this environmental assessment statement has stood in the way of correction,and so it is a big issue with me.

Let's go on with this thing. I don't wish to belabor this particular point because it is there, we have to live with it.

But let's look now as far as this FDA standard. As a man who has worked with pollution control in South Dakota for several years, I recognize the need to establish a standard and I will back you up all the way on that 0.5 ppm standard; I think it is a good one. I do want to ask you a question now, though, and this I think is important.

Do you allow a percentage variation or an occasional variation of the standard in the tuna fish industry now or is this an absolute standard, Mr. Ronk?

MR. RONK: There are a number of control programs in the pollution industry that are going on now. I think the tuna program is the most widely known. There is also a control program in the halibut industry that you are probably not aware of. There are also some other control programs. These programs are very expensive. The Japanese Government is paying out more than probably--these things are costing probably between $2 and $3 million a month.

There is a very complicated statistical control program that is used in the tuna industry based on size, species and age of the fish involved. The same sort of scheme works in the halibut industry and perhaps about as much as 10 percent of the larger halibut have been held off the market in cold storage now because of the levels above 0.5 ppm. We would think that we would have 95 to--we have about 95 percent confidence that we will never release a lot of fish above 0.5 as far as the industry's tuna control program is concerned.

When we talk in terms of guidelines and quality control programs we talk in terms of statistical assurance that a lot will not be released above these guidelines. Now, this is a lot average. That is why we do composite analysis rather than individual fish analysis. The composite analysis generally will have a lower value than the individual fish analysis, the highest ranges that you will find.

I have noticed in some of the presentations here that people are concerned about the individual variations within the fish, and you will see a rather large standard deviation if you are going to look at large numbers of samples of various fish of various sizes and ages. But if you start to run tuna fish where you are going to have--or halibut is probably a better indication, because they are sold--all fish brokers, and the brokers sell them on the basis of size so that they are graded according to size. When you start to grade fish that are over 125 pounds you are going to start to find a certain very small standard deviation between these fish as far as the law is concerned. If you are going to talk in terms of six northern pike from small size, the legal minimum, whatever that might be, up to fairly large fish, you are going to find some fairly significant standard deviations.

But the guideline is set up and our enforcement programs and our food analysis programs are set up along these lines to allow only a very statistically small portion to escape our purview. To go to a 99 percent confidence level, for instance if you had a thousand-pound lot of fish, you would have to increase your sampling probably, oh, seven or eightfold. Instead of looking at 12 individual fish selected at random, you might have to up this to perhaps in some cases more than 100 fish.

MR. MATTHEW: In other words, what you are saying is that if I go down and buy tuna, I am assured that the lot had an average concentration of less than 0.5 ppm, but that a particular can could exceed it occasionally?

MR. RONK: It is the odds. The odds would be less than--or I guess the odds would be less than, oh, maybe one and a half times in a lot of 100 you might find a can of poisoned fish. That would depend on the species. In shipjack you would find none; if it was albacore you would find a different situation; if it was yellowfin tuna you would find a different situation; if it was bluefin tuna a different one, and dogtooth tuna a different one. So these are the kinds of looks that you have to make.

As long as I have the microphone I think I will make one other statement about one other remark you made. I think Dow Chemical and some of the big chloralkali plants would be very happy if the introduction of elemental mercury or mercuric chloride or inorganic mercuries in the stream beds did not result in this methyl phenomena.

MR. MATTHEW: It does result in the methylmercury phenomena. I didn't mean to imply that it didn't. We don't know the mechanics of the release, but it is a slow release; we are convinced of that.

MR. RONK: I don't see how you can be convinced of the slowness or the fastness of it since the mechanism of it is just not that well known.

MR. MATTHEW: Good point. I stand corrected, because I am not that sure.

But I do want to point out, though, that the mercury that you are measuring is not methylmercury or toxic form of mercury, it is mercury sulfate.

MR. RONK: But I think the point is that regardless of the form of the mercury that goes into the stream, what ends up in the fish is methylmercury and that is the toxic form. If you go into the eastern part of Lake Erie now from Sandusky, Ohio, west you will find 40 percent of all of the game fish, the walleyes, the northern pike, will be above this 0.5 level from the introduction of these type compounds. The same thing will happen when you introduce a mercury that is used as a catalyst in the production in the acetylene industry, so that--or the same thing will happen if you introduce an organic mercurial such as phenylmercuric acetate, which is used as a seed disinfectant. The same thing will happen if you introduce any of the other mercurials. It doesn't make much difference whether they are insoluble or not.

The other thing is that they all combine with the sediment; they will be in the sediment perhaps in a range of 20 miles away from the plant site, and they will continually release this into the--

MR. MATTHEW: Let's look at it in relation to the problem, then. Really, as I see it, the decision has to be made on interim treatment. And the reason I brought this out is that I am saying that there are enough tailings in 109 miles of Belle Fourche River and Whitewood Creek that we are not going to see any significant change in that methylmercury update by effecting a one-year correction. You see? Because we will have the problem corrected within a year. Now, maybe it will mean then that the erosion doesn't go on for a year, but we are not going to be able to see any measurable change, I don't believe.

MR. RONK: I think if you look at Port Lavaca, Texas, in January of 1970 the oysters in the bay were 5.0 ppm. In December of 1970, after a pretty complete abatement of the mercury coming into the stream at Port Lavaca, the oysters were down below 0.5 ppm.

So in using freshwater clams or using oysters and shellfish, these are a prime indicator of the metals content of the stream, what is happening in the stream, because they are going to use particulate matter for food and they will select on the basis of size. That shows you how dramatically the beginnings of a change can take place in a short period of time, so that I think what you are really talking about is how soon do you want to make this beginning. How long it is going to take for the entire biosphere to recover is unknown to anyone at this time, and I have heard estimates of 10 to 100 years to never. But I think there are some scientific indications, such as this particular instance, where there was the beginnings of recovery as soon as the pollution problem was abated.

MR. MATTHEW: Well, yes, I think the recovery is bound to begin at that point. What I am saying is that for the expense and for the complications involved with the actual corrective project--we can proceed faster with the total project if we don't have to tear it apart.

MR. STEIN: You know, I agree, and we possibly should have had these discussions before, because the points you have raised, Mr. Matthew, are the points I am sure we have had discussions about over the past few months with Food and Drug, EPA, the Federal establishment. We have been through this. I think the questions you raise are precisely the questions we raised for a long time.

Let me try to say that the Federal Government has come out with a short circuit on this. You know, if you were here at the beginning, and I don't know if you were--

MR. MATTHEW: Yes, I was.

MR. STEIN: --I mentioned mercury, cyanides, arsenic, I said we were going to use these terms and that we had to look at the facts.

Now, with metals such as arsenic and cyanides you may have a problem of toxic or nontoxic forms of convertibility or leaching, we don't know. We felt the same way possibly three or four years ago about mercury. The notion is, and I think Mr. Ronk has given you example after example, that where we have found mercury in whatever form put into the environment, we have found evidence that this gets changed to methylated mercury by whatever form, gets taken up by organisms which are put in the food chain and to animals eventually or marine animals, gets eaten by man and it is not very good for him.

Now, the theory that we have had and the basis of the regulatory program--I think the essential basis for Food and Drug and EPA is the same, that because this happens with mercury at any rate there is no waiting--is to get the most rapid program for its abatement. We have done that in case after case. We have dealt with 50 major industries. In many cases we have gone to court, and we have made special pleas and gotten on the docket in a matter of days or weeks rather than the normal case of waiting months.

And the reason for that is precisely what Mr. Ronk said. We believe that every day you are putting out mercury into the environment or into the water environment from whatever source might mean that eventually, or from our evidence it could probably mean, that that was going to turn one time into methylmercury and be taken into the food chain; we want to stop that as soon as we possibly can. Now, that is our judgment.

The question here that you are saying is something, and I want to make this clear, that we haven't applied in that case. For example, we have gone to major chlor-alkali plants, major pulp and paper plants, and we have asked them to reduce their mercury and reduce it now, not equate this to how much it was going to cost within a year. This has been the judgment after considering this in the Federal Government. And again I think the points you raise are good. But these are the discussions we had, and I want to give you at least the feeling or the consideration or the considered policy I should say of the Federal Government in both Food and Drug, EPA, and wherever we deal with the toxic materials, and how we have carried out our program.

Here is the push, and let me get on the other side. I have appeared before many groups, including the Congress, where I have been pushed to take the same position on lead, arsenic and cyanide as we have taken on mercury in the changing from what we consider a nontoxic form to a toxic form. I have indicated that our scientific reports are not yet in on it, and I just couldn't say it. But about mercury we certainly can. That is the one, and we have taken a position on that.

MR. DICKSTEIN: I would like to briefly make a point here, that the major problem of conversion of metals right now is in the mercury area; but what particular area is next ? I don't think we dare put any extraneous materials into the river and assume they are going to be safe.

MR. STEIN: That is right. Let's emphasize that. We do have a very active program dealing with all heavy metals. Now I see some industry people in the room. Since our mercury experience, whenever an industry asks me what it can put in the river, my idea on that is take it all out, because you never know what is going to hit tomorrow,and I won't know either.

Again, and I have said this many times because I have been so much involved in dealing with these mercury cases, sitting in Washington almost 24 hours a day during the peak--just sitting there getting the reports and sending these things out--if you were to have asked me 6 months before whether the putting out of metallic mercury was a problem, I would have said no. Heck, they weren't even included in the Public Health Service drinking water standards. I thought the same as every industry--that if you took the metallic form of mercury and you put it in water you probably were safe and home free. But how wrong we were.

Now, the point is, when they are talking about these other metals, I think we have to recognize the danger signals and the risk that any industry or anyone else may take predicating a long-term program of waste disposal just putting these materials into the environment without expecting someone to come up with something later and find it, because the intensity of the investigation of that is tremendous now. People are looking at all these materials very, very carefully, and what we want to do is try to work out with you an equitable program.

I think there should have been some kind of method in the development of this, and the question you raise, whereby we could have been in some way in touch with people like you so you would have been a party to the discussions, because--

MR. MATTHEW: It would have helped a great deal.

MR. STEIN: --the way you have talked here is precisely what I have been listening to and saying myself for the past year or so until this has evolved.

MR. MATTHEW: I can't argue with anything you said, Mr. Stein, because I agree with you. You have a responsibility as Government officials and public health officials have responsibilities, and having been in that area before,I understand your position, I think, and the position of the enforcement agency probably better than anyone else in the room.

However, I am faced with cleaning up the creek and I can see a great deal of problems associated with the final project as a part of this proposed interim thing. That is the decision you have to make here, is yes or no do we require interim treatment, because I don't think that enforcement action will be taken with the cooperative attitude that has been shown when we have a project going. I just can't believe that anybody would do this. But I can't see the need for interim treatment.

So I am arguing here saying that the interim treatment proposal is going to interfere with my project and, damn it, I don't want any interference. I want to get the problem corrected right and I want to get it corrected in a timely and efficient manner, that is what I am saying.

And when I look at these other factors and consider the things you have said--now, let's look at what you said. Mr. Ronk says, yes, you can get a mouthful of mercury that has better than 0.5 ppm. On an average--and we are looking at cause and effect relationships--we have actual statistical information to talk about now that you people have provided. This is what has been so good here.

On all the samples collected on the Cheyenne, let's look into this standard, the average is 0.32 ppm. Well, O. K., that doesn't mean much because who eats carp and suckers in this country? Very few people do. So if you pull out the edible fish, and I am talking now about the white bass and the northern and the walleye, you get a 0.38 average and that is getting pretty close to the FDA standard. But that is only 29 percent of the samples that exceeded that now, so if I go out there and I collect three northern, and that would be a damned good day for me, and I go home, one out of three of those fish is apt to be in excess of the FDA standard. Now, I have to be on a diet and I have to go fishing every day in there and consume a pound or a pound and a quarter a day to get to a defect relationship. And I think the chances are so remote and I think that we are at the peak of the mercury contamination in flesh, because I can't help but think that elimination of mercury from the process at Homestake is going to have some influence. God, I hope so. It is costing them a million dollars a year. And if it doesn't have some influence on the mercury concentration in fish,we are not getting much out of that million dollar loss that Homestake is suffering. You see? And that figure is a nebulous one. I will let Jim Harder, who is aware of that, give you the actual figure. I use a million dollars because it is easy for me to remember.

The point is this, then, the chances for me to get a fish right now on the Missouri are one in three that exceeds the FDA standards,and then I have to eat a lot of it and I have to be on a diet, darned near, to get it.

I think that we are at the top of the cycle. I don't care what we do now. If we continue it for a year I think that the fish contamination, mercury contamination in fish, is going to fall off to an extent, maybe not a measurable one, but it shouldn't get any worse because the stuff that has been discharged there has been going on since 1876,and if that doesn't provide a stable situation of uptake and discharge, nothing will.

We have to consider, I think, this percent error in the testing also here, and there is another factor to consider. We have prejudiced reporting here, and I can't blame anybody for this because I have been prejudiced by Whitewood Creek for a long time. And when you see Whitewood Creek flowing by you say,"Let's get Homestake." All right.

You are advocating in your report and your recommendations that we post the Cheyenne Arm of the Belle Fourche River. But you see, on Whitlock Bay, for instance, we had 0.26 average, which is a little bit less, but from the standpoint of experimental error it is not too significant. Fifteen percent of the samples are bad, so up there if I go on Whitlock Bay 1 out of 6 of my fish will have an excessive amount of mercury. But you aren't proposing that we post Whitlock Bay.

We found 16 percent of the samples were bad in Angostura Reservoir. Nobody is advocating that we post Angostura Reservoir. We found a bad sample up on the Redwater River, and this is the statement that shows some prejudice, I think, said that these samples swam upstream from the contaminated reach down below--about 50 miles, I believe, it would have to swim. And it was a carp; probably wouldn't eat the thing here in South Dakota, but nobody is advocating posting Redwater River.

It sounds to me like we are prejudiced against the Cheyenne Arm and the Belle Fourche River because of prejudice against Homestake. Now, I have been prejudiced against Homestake for a long time. I have wanted to clean that thing up, but I would report objectively and my recommendations would be if we are going to post one part of that doggone reservoir we had better post the rest of it. And we had better do some more investigation because we are interested in the health problems in Whitlock Bay just as much as we are in the Cheyenne Arm of the Oahe Reservoir.

I want you people to consider that and I hope you do. I think that I will shut off because I am taking much more time here than I had planned. I plead for objectivity in your decisions. We have to recognize that Homestake is the major industry. The western part of South Dakota needs to develop that gold ore resource that we have in the northern hills, very important to us, and I think that we want to consider the economic and the social impact of the decisions that are made here today as well as the water pollution control aspects of the problem.

Thank you.

MR. STEIN: Thank you.

Any comments or questions?

If not, thank you very much.

Dr. Hayes.

DR. HAYES: Yes. I would like to ask Dr. Jack Redden, who is Professor at the South Dakota School of Mines and

Technology and who is today representing our Mercury Coordinating Committee which we have formed in the State when we first became aware of the problem in 1970 of some magnitude. I think Jack will make his report from the floor.

JACK A. REDDEN

DIRECTOR OF ENGINEERING AND

MINING EXPERIMENT STATION

SOUTH DAKOTA SCHOOL OF MINES

DR. REDDEN: Mr. Chairman, conferees.

My name is Jack A. Redden and I am the Director of the Engineering and Mining Experiment Station, South Dakota School of Mines. The statement I am presenting today is on behalf of the South Dakota Mercury Coordinating Committee and does not necessarily reflect the official position of the School of Mines.

The Mercury Coordinating Committee was formed in December 1970 at the request of Dr. Robert H. Hayes, and I quote, to "be responsible for collecting, evaluating, and distributing all of the State's work on mercury." Others who serve on the Committee are:

Dr. Otto Neuhaus, Department of Biochemistry, University of South Dakota School of Medicine.

Dr. Oscar Olson, Station Biochemistry, South Dakota State University.

Mr. Don Mitchell, State Chemist, State Chemical Laboratory.

Mr. Robert Hanten, Fisheries Specialist, South Dakota Department of Game, Fish & Parks.

Mr. Ben Diamond, Director, State Health Laboratory.

In their Committee efforts, the members do not necessarily represent their respective institutions, but all have contributed to the study of the mercury problem from the point of view of their own specialties and competencies.

On October 11, 1971, a special meeting of the committee was held in Pierre to review the information presented in the EPA report "Report on Pollution Affecting Water Quality of the Cheyenne River System, Western South Dakota" and to examine the recommendations presented therein in some detail.

Since the above-mentioned report had not been received in time to circulate to the members prior to the October 11 meeting, no action was taken on the report and the recommendations at that time. Later, when the members had had sufficient time for study, comments on the recommendations were solicited by mail. This presentation, then, is a report on the consensus of five of the six members of the South Dakota Mercury Coordinating Committee:

Actually we have had a report from the sixth member since that time and he is in agreement with the basic recommendations.

Recommendation 1, this was from the black book report, regarding the contruction of permanent treatment facilities -

> All members agreed emphatically as to the need; three questioned the deadline.

Recommendation #2 regarding construction of interim treatment facilities -

> All members disagreed with the recommendation; all believe the money should be spent on permanent facilities; and four consider the interim facilities would be hazardous in term of containment.

Recommendation #3 regarding existing tailings in the system -

> All members agreed as to the need for an inventory; all would agree to recovery if methods were available that would not cause more mercury to be released than recovered; all agreed to containment with some reservation as to disturbing the deposits and releasing more mercury.

Recommendation #4 regarding arsenic in wells -

All members agreed.

Recommendation #5 regarding public warnings about fish consumption -

Three members did not agree, one member agreed, and one member agreed providing a health hazard study was made a part of the recommendation.

Recommendation #6 regarding the inventory and composition of tailings piles north and west of Lead -

All members agreed to the inventory and composition; three expressed concern regarding costs of containment; and three expressed interest in ownership of the abandoned tailings.

And by that statement I don't mean that they wanted to buy the tailings. (Laughter.)

Recommendation #7 regarding water quality standards for Whitewood Creek and Deadwood Creek -

All members agreed, but only after permanent treatment facilities have been completed; three questioned how soon beneficial uses could be expected.

Thank you for your attention.

MR. STEIN: Thank you very much for a very constructive statement.

Are there any comments or questions?

If not, thank you. That was very helpful.

DR. HAYES: I might, if I may, Jack, add for the committee one of the things that we had discussed and hoped would get to the attention of the conferees is, Dr. Redden has pointed out each of the institutions involved have considerable capability of doing some of the work which has to be done and have already, at least unilaterally, in each institution done certain amounts of work--everything from studying hair and nails in populations along the Cheyenne Basin on down to studying demonstrable levels of mercury in pheasants, for example, and the other part of the fauna. And I really think that the committee was most appreciative of the fact that the conference was going to be held and we would be conferring. I merely wish to make its offer again of their facilities and their people in the interest of getting the problem solved.

MR. STEIN: All right. I think it very significant, Doctor, too, I might say, that the committee's recommendations pretty much were consistent with the Federal recommendations and the State recommendations, allowing reasonable variation for the personalities involved. No one comes up with precisely the same solution, but your suggestions are pretty much the same and I think we are very, very close together.

Do you have any more presentations?

DR. HAYES: Yes. Dr. Kilness, Rapid City physician, a practicing physician, I know had asked to make a statement. I know that he probably may pose some questions as well as make a statement.

We would sure like to hear from you now, Dr. Kilness.

A. W. KILNESS, M.D.

PRACTICING PHYSICIAN

STATE OF SOUTH DAKOTA

DR. KILNESS: My name is Dr. Kilness. I have been a licensed physician in South Dakota for 22 years and I have completed my medical training in South Dakota and Louisville and had a surgical residency in Flint, Michigan, and five years prior to one year ago I was a staff surgeon with the Veterans Administration Hospital in Hot Springs.

I have been interested in the past year in doing independent research and some study on various trace elements in the Great Plains area because I have seen patients from the areas of Nebraska in the northern areas, from eastern Wyoming, from central South Dakota west of the Missouri River, and from the southern half of North Dakota, which area encompasses the draw for the patients that we serviced at the Veterans Administration Hospital. Any remarks I have do not represent the views of the Veterans Administration. I am not employed by them at this time. I am doing independent study and research.

As a fledgling physician in 1953 I had always been interested in the general health of people. Trace element studies don't mean much to the average physician. When a patient comes to me they usually say,"Doc, I don't care what you do, but take the hurt out and get me well." They put it very bluntly, and so I think this has something to do too. We have got to get down to the level of the patient.

We have been studying fish and how many fish does it take to poison an animal. I would say that I would agree with the government standards set up. I wouldn't want to eat fish with a lot of mercury; I wouldn't want to eat fish with over a part and a half of mercury for a period of time because I think I would probably develop a neurological disease.

On the other hand, my purpose in coming up here today didn't have any specific purpose because I don't have any research grants; I don't have any axes to grind, but I would like to introduce one subject. I have heard a lot about arsenopyrites; I have heard a lot about other trace elements. I think Dr. Hayes mentioned the fact that there are other elements that might be studied in this area which might have a bearing on whether or not mercury and its compounds might be a health hazard to people. To that I would like to address my remarks, and then I would like to ask you a couple of questions.

In the first place, this past summer I had an opportunity--I have been studying some selenium research off and on for over a period of 15 years as a physician. I had a selenium research project with the Veterans Administration down in Hot Springs, South Dakota. We found what we considered to be elevated blood and urine levels of selenium in some patients. We didn't draw any definite conclusions at that time; I didn't publish any paper about it. At present, in the past year, I have done a number of analyses on selenium and other trace elements--done on people both in South Dakota and Wyoming.And I have been traveling in Colorado, and so on. And not being paid for it I have either been very foolish or else my patients are very good friends so that they are worth it, and I have always felt that way.

But I would like to come to the point and I would like to ask. I have had probably a compilation of 800 papers predominantly on selenium but also on trace elements in relationship with mercury. Recently there was an article referring to the fact that Dr. Thomas Eye, who was alluded to yesterday in a paper about selenium, had mentioned about the mercury problem as being one that should be weighed very carefully. He also mentioned that he found selenium contamination in some of these species of fishes in Japanese waters. In all of these analyses selenium can be potentially a very toxic element. I know that it is being considered as an essential trace element in nutrition, but in large amounts it can be very lethal just as mercury in large amounts can be very lethal. With all respect to trace elements, I think that the field of mollecular biology is going to be the field of preventive medicine in the next 10 years.

I have taken a number of samples of blood and urine from people, and I don't quite know what to think except that I know that in the same areas drained by the Cheyenne River Basin and also in other areas I have found large amounts of selenium in the vegetation; I have found large amounts of selenium in the water, in some cases exceeding by 50 times the levels allowed by the Public Health Service. I don't know whether anyone should get excited by that. I can't put my finger on a patient and say that that patient has been made ill by it. But as a physician, and I take care of their health and I intend to do that this coming year again when I get back in practice in this region, I don't think I will have reached any great conclusions.

I think the Food and Drug Administration and I think the toxicologists are going to have the answers on this. There are going to have to be guidelines set. But I would like to state that in this particular area where there is a lot of selenium that the problems of mercury and selenium and perhaps cadmium ought not be divested of one another and that comprehensive trace analysis reports should be done of these other things.

That is all I have to say.

MR. STEIN: Just a moment, Doctor. You know, I should have waited and let you talk before I responded to Mr. Matthew, because you said precisely what I was going to.

Before I turn it over to the experts I should say, just as an administrator here, that we do have cadmium, selenium and mercury on the list. They are being examined together and in concert and individually, and we are working very hard on that.

Now, do you have any other comments to make?

MR. RONK: Yes. I think Dr. Shibko would like to say a few things about selenium.

But these are problems, and as was pointed out there were other analyses in the book. I think the points that you made are very well taken. There is a great deal of interest in cadmium toxicity. I recall that when some of the fish bills were discussed, the Hart bill and the administration fish bill before the Congress now, these questions were also raised. In fact, one of the fish bills has a hazardous materials section to it which would say that the Food and Drug Administration is far too conservative in our approach as to metals problems and that they want to put in a bill; "the Secretary is charged with the responsibility of establishing test protocols for these other materials."

The shellfish picture is probably the most appropriate picture to tell you about the numbers of problems that you can have with metals. For instance, the average level in oysters from the whole eastern part of the United States would be about 3.0 ppm cadmium. Now, if this were very well distributed through the diet we would think that that might present itself with some sort of a health problem. Some crops have been found to run high levels of cadmium. For instance, the spinach survey that the FDA carried out very recently found some samples that ran as high as 1 ppm, claimed to be due to the geological formations in the area.

We are concerned with these other metals, and I think that you are going to have to be concerned with them too in any type of protocols that you build. Things have to be flexible enough so that they can relate to each other from that.

Dr. Shibko,would you like to say something on this?

DR. SHIBKO: As regards the presence of other heavy metals in foodstuffs, we are mainly concerned with their chemical form and their biogradability and biotoxicity. These may vary a great deal depending on the actual type present.

In the case of selenium, we know that selenium occurs in fish, but apparently this doesn't seem to be readily available to the organism when the selenium contained in fish is fed to experimental animals. We don't know if this situation makes this demand too.

As regards the indirections of many different types of heavy metals in the diets, particularly with selenium, some experimental work in Czechoslovakia at least has suggested that when combinations of mercury and selenium are injected into experimental animals, the selenium may have some protective mechanism against the action of mercury. We don't know if this occurs when these compounds are present naturally in the food supply.

The whole problem is very complex, and there is a great deal of research needed to understand the indirections between these heavy metals when they occur naturally in foodstuffs.

MR. RONK: For instance, we have initiated feeding studies for cadmium in the Bureau of Foods. We have induced

50 ppm levels of cadmium in oysters from the southern part of the United States, and these will be fed to experimental animals to find out whether or not there is another phenomenon that takes place. Cadmium is ordinarily associated with zinc; it is an impurity of zinc. It may be that zinc, an essential element, actually has a beneficial effect on the cadmium level also; so that if the cadmium level is high and the zinc level is also high, the effect on the animals involved may not be as great as if cadmium were introduced by itself, because I believe that that has a tendency to accumulate in the body throughout the lifetime of the individual.

DR. SHIBKO: Yes.

DR. KILNESS: I would like to ask Dr. Shibko, I am well aware of the work that has been done with the potential or possible use of certain compounds of selenium in reducing levels of mercury. As a matter of fact, I am sure that he is well acquainted with the work of Dr. Parizek.

DR. SHIBKO: Yes.

DR. KILNESS: --of Czechoslovakia, whom I have talked to about this problem. But I have also talked with other physicians and so on who have not found this to be true, and one of the problems is that we are dealing with methyl radicals in both programs, in both selenium and mercury, and actually at this stage I don't think that we can state that--I myself, if I had a patient with mercury poisoning, wouldn't want to give him selenium, because I don't think that we have enough objective news at this time to state that I can help that patient.

DR. SHIBKO: Well, we are not suggesting that you should give selenium. (Laughter.) These are problems that have to be studied much further so that we can understand the indirection between these compounds, particularly when they occur in the food supply.

MR. DICKSTEIN: Just briefly for the Agency, there is a great concern within EPA on hazardous materials and hazardous materials being discharged in the various waste streams to the extent that we are mandated by Congress to come up with a list of hazardous materials and hazardous concentrations, and this is being worked on right now.

DR. KILNESS: This is my only purpose for bringing this up as a physician, because I have a number of pictures here of animals--I have had movies taken of animals, I have had movies and so on, of people who have injected large amounts of selenium, and these are in these mercury areas. I have got pictures here of animals, which you will be welcome to inspect, that I know have toxic levels of selenium in them. And if some other physician got hold of these he might say, well, this poor man has consumed a little bit of fish that had a little mercury, but he may be sicker than the devil with something else. I say he may be; not necessarily.

MR. STEIN: Well, Doctor, I think your point is well taken, and I checked this with Benjamin Lim, who is our specialist and looks after toxicology for us. He concurs with the Food and Drug representatives and he is going to say the same thing.

I do think what we have to do particularly--and I think this is the thrust of the program--is to enable the physicians or someone else to come up with these differential diagnoses and know what we are hitting and be sure and deal with the causal problem rather than anything else. You might point to one thing, and this possibly is what Mr. Matthew pointed out here, that when you are not quite so sure, you take the whole range of heavy metals and you move against the whole business. It is much better, of course, particularly from a physician's operation, to go ahead when you know precisely what you are dealing with. George Orwell, who wrote 1984, in one of his earlier novels, Burmese Days, said, "Blessed are those with identifiable diseases." (Laughter.) You know, we are lucky when we know that.

When we don't have that, and I think you spotlight it, this is the problem. When we have these areas of no knowledge or just suspicion and not knowledge, to get at the cause we may be dealing with a broader spectrum than we would if we were precise. I think we are working to get as precise as we can. As far as I can see, there is a lot more emphasis in this field now since the mercury publicity than there had been for many years before that.

DR. KILNESS: Well, my purpose in bringing this up was because as a physician I have always been interested in toxicology. I am not an expert on toxicology. I've delivered a lot of babies, I've done cancer surgery on a surgical residency, but I've always been interested in trace elements. In 1953 I wrote the first paper in South Dakota on the deaths in infants due to nitrate poisoning,* and subsequently I found out that I was the first physician in the Midwest to delineate that problem. Then I also learned in 1953, I think, that there were 49 deaths in Minnesota that were recorded of the nitrate poisoning, making it one of the recorded types of poisoning.

So I am only stating this so you don't divest and put all of your problems and so on into the mercury problems. I think that these other trace elements should be considered because this contiguous area to which my patients have been, have sometimes elevated concentrations of selenium. I don't

*Entitled Heavily Nitrated Water and Methemoglobinemia in Infants.

know the particular instances of what the levels are. I do know that the water levels here are far in excess of the Government standards in many respects and I would wish that attention would be on these other elements with relationship to the mercury problem.

Thank you.

MR. STEIN: Mr. Grimes.

MR. GRIMES: Two points with respect to whatever inquiries might be made into selenium in particular.

No. 1, you have quite a laboratory here in South Dakota of widespread knowledge among the ranchers in western South Dakota with respect to concentrations in these places, pastures which are not grazed simply because of the harm that comes to the cattle. Now, what effect in the cattle themselves as they make it to the market and are consumed by the human, I do not know.

Secondly we have a continually increasing use of waters which are known to contain selenium for irrigation purposes. The extent to which this is concentrated in those crops which in turn get into the human food chain might be of concern to any investigator that might be looking into this.

And with respect to the current work which you are doing along these lines, especially in FDA, the experimenters may want to inquire into some of this practical, on-the-spot, common knowledge which exists in I might say a natural form as a basis for additional experimental results.

MR. RONK: I think your point is very well taken. We have known for a number of years, of course, that there are high selenium wheats that are grown in both North and South Dakota, and this has been of some concern to many toxicologists and some nutritionists. I don't think it takes much insight when you listen to the radio in South Dakota and listen to the stock reports in the morning to figure out that we know an awful lot more about animal nutrition than we do about human nutrition, especially as regards metals. I think the tools have only become available in the last--well, really commonly available in laboratories since the mercury crisis, where everybody and his brother has a P&E atomic absorption spectrophotometer now, and the universities and other laboratories now are equipped to begin to look at the trace metals with a very exquisite eye. And I think we are going to find out a great deal more information about the role of trace elements in our diet, and we are going to find out more about human nutrition than we knew before.

One of the difficulties, and it has been brought up a number of times, that we will never be able to relate to is the difference between testings that we are going to be able to perform with animals and the testings that we are able to perform on humans. We will never be able to do the kinds of protocol testing that we do with animals when we are talking about human beings because of the real ethical considerations that are involved here; so that most of our information is going to have to come from animal studies, and we are going to have to develop protocols and test animals and really find out what are the relationships involved here to man. This is going to take some time, but I think the beginnings have been made, and I think we will see quite a large advance in this area over the next five years.

MR. GRIMES: What might be done, of course, is to use the natural laboratories as well as the artificial ones.

MR. STEIN: Right.

MR. RONK: Well, I don't agree with that entirely. I think we are going to use these systems to greater advantage than we have in the past.

MR. STEIN: I would like to before we recess say that I wholeheartedly agree with Mr. Grimes, and this is often overlooked when we have these researches. I have found, at least in doing river work such as water research, if those fancy, young, and eager Ph.D.'s had looked up from their computers long enough and had gone out and talked to a man who had been fishing the river or a river rat, he might learn something. They know how the river is changing and what is happening and that might give them insights. I have always said that this was the important thing for a researcher to do. Very often, if you can find a farmer who has been dealing with the problem of feeding cattle and he knows they aren't making it on a certain field with something, that is the man to look for.

I think this is what the doctor is doing when a patient comes in and tells him, "Doc, I hurt, fix me up." You use the same technique. If our researchers only did that, we would be better off, one.

Another thing I would like to do is bring our researchers to these enforcement conferences. I think the kind of queries they get in this quasi-adversary situation--as opposed to the seminars they go to--might jog their thinking and send them back refreshed to the bench. I would agree with Mr. Grimes that we really should look into the practical experience of the people in South Dakota.

MR. RONK: That is very true.

MR. GRIMES: I have found that there is a lot of knowledge here that is essentially unknown.

Also a bit of warning. If you send the researchers you are talking about out into the countryside to obtain this, the customary thing in going to a ranch or a farmstead is to sit in the car and blow the horn until you have somebody to keep the dogs off of you. (Laughter.)

MR. STEIN: Right. That is the best advice you have given.

Yes.

DR. KILNESS: I would agree with that statement, except for the fact that most of the people that I have done analysis on in the past year, and some of them have been patients of mine, would treat me like they would a hunter coming onto his land--if he would come in and leave his fence down, watch out. But if you treat him like a friend he will probably treat you as a friend. And I think that the patient has most of the answers that we find, not the laboratory.

MR. HODGINS: Mr. Stein, I would like to ask a question of Dr. Hayes or Dr. Kilness or anyone else here who may know.

How many patients are treated in the year in North America for diseases that are caused by mercury?

DR. HAYES: I think I yesterday reported the fact that the only known toxicity cases where a clinical condition existed that would be brought to the attention of the doctor were the New Mexico victims that ate the treated seed grain or ate the hog that had been fattened on treated seed grain.

There are some--one I think we mentioned, I think you referred to as the swordfish lady--

DR. SHIBKO: Yes.

DR. HAYES: --known exposure to mercury, at least presumed known exposure to mercury in swordfish. There may be some others, like the case I mentioned from South Dakota where a patient suspected he might have been poisoned but didn't have any clinical symptoms.

I think these are the only exposures I know of right at the moment. There may be some new ones.

MR. RONK: Well, there are varieties of exposures. If we want to talk about people that are treated for mercurial poisoning from foods, this is--we would hope that there is a very low incidence of mercury poisoning in the United States from this source and that it is a subclinical thing. As Dr. Shibko pointed out, the tools do not exist to measure this type of damage, neurological damage.

But as far as mercurial poisonings in the United States, this is fairly common. These are mostly industrial inhalation phenomena and there have been serious poisonings in paint plants where they will use phenylmercury acetate as a fungicide. There are a number of people who are in the medical practice, Dr. Goldwater for one, who do extensive consulting work with industry on industrial poisonings. There are several people up in Michigan that have an extensive practice in this area.

DR. HAYES: I think your question was one related to food ingestion, was it not?

MR. HODGINS: Yes, this is right. In view of the replies, without detracting from the hazards that may relate to consuming fish in South Dakota, I just might mention that according to the news yesterday 210 people in South Dakota died on the highways.

MR. STEIN: Oh. That is right. But, you know, I have always made a remark like that—I bet you have more people in South Dakota working on homicides than you do on cleaning up the environment. And I don't say that about South Dakota; that is true everywhere. I don't know that that is right.

Let us recess for 10 minutes.

(RECESS)

MR. STEIN: Let's reconvene.

Dr. Hayes.

DR. HAYES: Thank you, Mr. Chairman.

At this time I would like to call Mr. Jim Harder, who is the Vice President and General Manager for the Black

Hills Branch of the Homestake Mining Company, and ask him to give us some insight into what industry is doing in response to all of the problems.

JAMES O. HARDER

VICE PRESIDENT-GENERAL MANAGER

BLACK HILLS OPERATIONS

HOMESTAKE MINING COMPANY

MR. HARDER: Thank you for this opportunity, Mr. Chairman, and panel, conferees,ladies and gentlemen.

I apologise to you for the enterprising Rapid City Journal reporter who reported my statement before I gave it, but I have a prepared statement here which I would like to present orally and would like to have the statement entered into the record. I believe copies are before each of you and I would like to have it entered into the permanent record of the hearing and I will proceed--

MR. STEIN: Without objection, your complete statement will be entered into the record as if read.

Pardon me, you have an insert in the back and I don't know that we are going to be able to handle that.

MR. HARDER: I would say don't worry about it, the samples are described in a listing by location and I don't believe the map is essential. It is fine for the panel.

MR. STEIN: We will accept the map as an exhibit.

Let me give you the problem we have. In dealing with a map like this they have to be hand inserted and it more than doubles the price of the record, and if we reduce it in size to fit on a page you won't be able to read it.

MR. HARDER: I would suggest that it be used for the panel's purposes but not made a part of the record.

MR. STEIN: Thank you very much, sir.

(The above-mentioned map, marked Exhibit 1, is on file at Headquarters, EPA, Washington, D. C., and Region VIII, Denver, Colorado.)

MR. HARDER: And I will be giving you some color photographs later to which the same will apply, they are for the panel to look at but not part of the record.

MR. STEIN: Thank you. They will be treated as exhibits and kept on file in Washington and our regional office.

MR. HARDER: My name is James O. Harder. I am Manager of Black Hills Operations, Homestake Mining Company, and also a Vice President of that company. This conference has been called to consider the mercury pollution problem in the waters of western South Dakota, and will also consider pollution of such waterways by cyanide and other heavy metals. Particular emphasis is being directed at the Whitewood Creek-Belle Fourche River (north fork of the Cheyenne) and the Cheyenne River system. For many years the Homestake Mining Company has deposited its industrial wastes and the municipalities of Lead and Deadwood, South Dakota, have deposited their raw sewage into the waters of Whitewood Creek. This statement must of necessity be rather lengthy because of the complex nature of the control of such discharges which, unless handled in a realistic and reasonable manner, may very well determine the very existence of the gold operations of the Homestake Mining Company and the stability of the communities of Lead and Deadwood.

In order for the conferees to thoroughly understand the problem, it is necessary that you be presented some historical information relating to past operations of Homestake. Our gold mining operations at Lead, South Dakota, commenced in 1878 and have continued with little interruption since that time. Mercury was used in the extraction of gold from the beginning, and Homestake has discharged metallic mercury in varying amounts into the waters of Whitewood Creek for nearly 100 years until December 28, 1970. On that date we discontinued use of mercury in our metallurgical plants at Lead at the request and insistence of the Environmental Protection Agency. In order to secure greater extraction of the gold in our ores, the mercury process was supplemented in the year 1901 by the introduction of the cyanidation process, as a result of which for the past 70 years some low toxic cyanates and a minimal amount of the more toxic free cyanide have also been discharged by Homestake into Whitewood Creek.

Tailings are fine grained, nearly inert rock, product resulting from grinding processes in our milling plant. We mill approximately 5,000 tons of ore per day. The coarser tailings or sand fraction, as they are called, are put back into the underground workings of the Homestake Mine to serve as fill and to support the ground structure. This amounts to about one-half of the total quantity of tailings.The mine cannot accept more, because the crushed and ground rock occupies about twice the volume of the solid rock. The excess must be disposed of outside the mine. The finer silt-like tailings, or slime as they are called metallurgically, are transported via pipeline from Lead, South Dakota, to our slime plant in Deadwood, South Dakota, a distance of 3 miles, for further cyanidation treatment.

There are approximately 3,000 tons of tailings discharged into the waters of Whitewood Creek, from both the Lead and Deadwood operations each day. The tailings are mixed with about 12 million gallons of water per day. I struck out the word "discharge." Really that sounded like it was 12 million gallons out of the plant, and that is not true.

Whitewood Creek is a moderately rapid mountain stream which runs an approximate distance of 25 miles from the Lead-Deadwood area to the point where it joins the Belle Fourche River, which is the north fork of the Cheyenne River. For the first 8 miles from Deadwood, Whitewood Creek runs through very rough, rugged, mountainous, canyon terrain until it reaches the flatter agricultural lands of Whitewood Valley, which continues to the point of its confluence with the Belle Fourche River. A number of ranch dwellings are located near Whitewood Creek in the valley. During the first quarter of this century, Homestake made settlements with all landowners abutting Whitewood Creek to its confluence with the Belle Fourche. By the terms of this settlement, Homestake obtained the right, not only to flow its tailings in the stream, but also to flow tailings over, under and across the lands of such property owners. These vested rights acquired by Homestake, for which either present owners or their predecessors in interests were duly compensated, are a matter of record.

Also of historical interest is the fact that in 1936 a number of ranchers owning property contiguous to the Belle Fourche River extending from its confluence with Whitewood Creek for a distance of approximately 30 miles downstream formed a group in which one of them appeared as a party-plaintiff suing Homestake for damages in the U. S. Federal District Court--change "Circuit" to "District"--in which injury was alleged to their standing cottonwood timber, by overflow of tailings on their farmlands, by cattle bogging in the river, from harmful effects of livestock drinking contaminated water,and from killing of fish.

Homestake vigorously opposed the suit by the introduction of considerable evidence through the testimony of numerous expert witnesses, aerial photographs, several hundred photos, maps, a timber cruise, and many other items in refutation of plaintiff's allegations. As a matter of interest, we had photos of a dairy herd drinking water from Whitewood Creek 0.5 mile below the point of mill discharge in Lead; a vigorous growth of cottonwood saplings in a solid 3-foot bed of tailings; livestock being pulled from bog holes above the confluence of the Whitewood and the Belle Fourche where there are no Homestake tailings, a situation not uncommon in western South Dakota; and aerial photos showing the timber growing below the confluence of the two streams had the same pattern as that above such junction. Catfish caught in the Belle Fourche River along the area in question were actually brought into court.

The plaintiff did not prevail in his claims. The court rendered judgment in favor of Homestake on a legal point raised by the company. Under an 1881 statute all mining companies were given the right to use the waters of South Dakota to the full extent of the capacity thereof without regard to the deterioration in quality or diminution in quantity. The plaintiff, and in fact all of the group of ranchers involved, acquired title to their lands by homesteading after 1881. There was not one scintilla of evidence introduced in the trial either that the waters of the Belle Fourche were so contaminated by the company as to make them hazardous for human health or for that matter was there any evidence that livestock sustained any damage by drinking such waters. All of this, of course, is ancient history.

Under a State statute, in 1935 the South Dakota Water Pollution Committee classified the waters of Whitewood Creek as a Class B stream, which is defined as "Those waters or parts thereof which are more important to the welfare of this State as carriers of wastes providing such wastes are not detrimental to the public health." Under a newly enacted statute of the South Dakota Legislature, no waters shall be designated as

Class B waters after December 31, 1973.

In this present era of demands for "clean water and clean air" I realize that the following statement will have little validity or acceptance; nevertheless, I wish to point out that in fact the waters of Whitewood Creek as they presently flow can be termed as detrimental in only two respects: 1) Our industrial discharges make the waters of the creek black or dirty gray, which may be characterized as offensive to the aesthetic sense to those who wish to see clear water. 2) Because of the presence of a large volume of our silty tailings in the stream, the creek is unsuitable as a habitat for trout. Numerous stream fishermen in this area will attest to the fact that apparently there is an inability to stock or propagate a sufficient number of trout in the streams of the Black Hills which do not run clear water.

In 1960, South Dakota State water pollution officials conducted a study of the waters of Whitewood Creek and came to the conclusion that such waters were not harmful to humans or other higher forms of animal life, but were damaging to lower forms of aquatic life.

However, I wish to make it very clear that despite our opinion as to the reliability of these facts, some years ago Homestake became convinced that current demands for improvement of environmental quality made it necessary and essential that we take steps to eliminate any possible objections to industrial discharges and to raw sewage discharged into Whitewood Creek.

Long prior to the current drive to clean up the environment, Homestake began earnest efforts to correct the problem. In 1964 Homestake employed at its own expense the engineering firm of Greeley & Hansen of Chicago, Illinois, to conduct an initial investigation into the disposal of industrial waste and the raw sewage of the two municipalities of Lead and Deadwood.

In 1966, Homestake employed the engineering firm of Kirkham & Michael and Associates, again at Homestake's expense, to conduct a further study. This study included disposal of industrial wastes as well as sewage and the possibility of developing a combined disposal facility. Both of these firms are highly regarded in the sanitary engineering field. In November 1968, at the instigation of State water officials and Homestake, a sanitary district was formed embracing the municipalities of Lead and Deadwood. Trustees to govern the Lead-Deadwood Sanitary District #1 were chosen by the electors in April 1969. In their dealings with Federal officials studying propesed plans for a project, this Board discovered that

Housing and Urban Development required an engineering study contracted for by the sanitary district, and would not accept the findings of the two private engineering firms hired previously by Homestake.

Accordingly, a third engineering study was made, this time by Brady Engineering, of Spearfish, South Dakota, at the request of the sanitary district. The net result of all these engineering studies, including additional ones made by Homestake's very competent engineering staff, led to the conclusion that the most desirable method of handling the problem is a joint facility which would treat both raw sewage and industrial wastes. Not only is there a very, very considerable saving in going the joint facility route, but the tailings in the stabilization pond are beneficial in the treatment and elimination of raw sewage problems. The cost estimate placed on this joint facility was $5.6 million. In connection with control of wastes in Whitewood Creek, including time of our own staff, the employment of independent engineers, and other miscellany, Homestake has already expended approximately $180,000.

The importance of Homestake's gold operations to the economic well-being of western South Dakota, in fact to the entire State, cannot be overemphasized. Some 30,000 people residing in the Black Hills area are dependent either directly or indirectly upon the company's continued ability to operate its gold mine. Approximately $18 million each year generated by Homestake flows into the business community of South Dakota in the form of wages paid, supplies purchased, and insert "local taxes" and modest dividends to a number of South Dakota stockholders. As I'm sure the conferees are aware, these dollars turn over from four to six times per year, generating further business activity, plus further tax collections for cities, counties, and the State. Obviously, any cessation of Homestake operations, with its consequent unemployment, would be a severe economic catastrophe to the Black Hills and to the entire region.

Again I wish to reemphasize that management is having a difficult time to keep this gold operation running on a profitable basis. Indeed, we have had several months this year when we have been operating in the red and we will be fortunate indeed if we wind up the year 1971 by showing a modest profit from our gold mine. All of which brings into focus the fact that any inordinate delay in the completion of the Centennial project will considerably increase Homestake costs, to our great detriment, and any unwarranted delays incurred--insert the word "by"--questionable temporary projects will merely add unnecessary residing in the Black Hills area are dependent either directly or indirectly upon the company's continued ability to operate its gold mine. Approximately $18 million each year generated by Homestake flows into the business community of South Dakota in the form of wages paid, supplies purchased, and insert "local taxes" and modest dividends to a number of South Dakota stockholders. As I'm sure the conferees are aware, these dollars turn over from four to six times per year, generating further business activity, plus further tax collections for cities, counties, and the State. Obviously, any cessation of Homestake operations, with its consequent unemployment, would be a severe economic catastrophe to the Black Hills and to the entire region.

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After exhaustive study, independent engineering firms and Homestake engineers have concluded that the most practicable, feasible and desirable site for a joint facility for a waste stabilization pond is located on Centennial valley. State water pollution officials have approved the project and have determined that the effluent from such a pond will meet South Dakota water quality standards and the EPA has given tentative approval to the project at the Centennial site through its regional offices. We believe that final approval for this site will be forthcoming from EPA. The cost as previously estimated at $5.6 million will probably exceed that amount. Based on the original estimate, EPA has been requested by the sanitary district to approve a Federal grant in the amount of $1.7 million to aid in the cost of construction. Of the remaining cost, Homestake has agreed to pay 50 percent thereof and the sanitary district would assume the other 50 percent.

It should be noted, however, that since Homestake pays 43 percent of the taxes in the two municipalities of Lead and Deadwood, Homestake will actually be paying approximately 73 percent of this portion of the local cost of the project. It is proposed to issue bonds to aid in financing the

Centennial construction. Specific plans for a bond issue cannot be executed until EPA gives final approval to the project, and both Homestake and the sanitary district are assured that a Federal grant will be available. Without such assurance, it would probably be impossible to secure a favorable vote at a bond election. Further delays and increased costs diminish the possibility of successful financing.

Briefly, the waste stabilization pond at Centennial involves the construction of approximately 8 miles of pipeline in the Lead-Deadwood area of varying diameters to the site of the pond. The pond area at that point will embrace 290 acres, although 524 acres will be necessary for the property needed to cover the outer perimeter. The dam to contain the discharge from the pipeline will be constructed from the soils at the site, will be 100 feet high and is designed for a storage capacity of 20 years. When first constructed the pond will have a detention time of 500 days, which will gradually lessen, and at the terminal time of the storage capacity the detention time will have been reduced to approximately 7 days. Homestake tailings will be deposited in the pond and will be disposed of in the pond. Likewise, the raw sewage of the municipalities will, according to the judgment of sanitary engineers, be completely treated in the pond. The effluent from the pond will be clean clear water conforming to State water quality standards. It will return to Whitewood Creek.

If domestic sewage treatment plants were built solely by the municipalities the cost is estimated to be $4.6 million. A separate treatment system for Homestake wastes was estimated to cost $4.5 million, or a total of over $9 million for separate plants as compared with $5.6 million for a combined system. Of course these estimates are now more than a year old and will have to be sharply revised upward.

The site selected as the most desirable by the engineers is shown on the U. S. Geological map as Centennial Prairie.

Before going into more detail on the Centennial project, the conferees should be fully informed on the nature of Homestake's operations at Lead and the cold, hard economic facts confronting the company for the past several years.

Homestake is the largest gold producer in the Western Hemisphere. At Lead, we produce approximately 38 percent of the annual gold production of the United States. The Carlin open pit mine in Nevada produces slightly in excess of 20 percent of total U. S. production. These two mines are the only properties of consequence producing substantial gold each year except that derived as a by-product from the huge tonnages mined by the copper mines in the Southwest.

Homestake has approximately 1,850 employees. In both 1969 and 1970 Homestake came close to achieving its goal of processing 2 million tons of ore each year. Gross revenues in 1969 were approximately $24 million and were reflected in higher gold earnings which ran approximately $2.4 million. In 1970, the grade of ore declined very slightly, the tonnage was approximately the same, but gross revenues dropped sharply, to approximately $21 million, the chief reason being that gold prices were substantially lower than in the preceding year. In 1970, net earnings from gold declined drastically to $750,000 reflecting poor gold prices, slightly lower grade, and higher operating costs due to inflationary trends.

Despite higher gold prices in 1971, ranging from $37.65 per ounce to $44.20, it has become extremely difficult to maintain Homestake's gold operation on a profitable basis. One very drastic loss has occurred in our gold operation in 1971 because of the suspension on December 28, 1970, of the use of mercury in our metallurgical process. This crippling blow to our metallurgical recovery process was at the insistence of EPA. Our metallurgist had estimated hopefully that when the use of mercury was discontinued, Homestake would suffer a loss of 0.5 to 1 percent in the extraction of gold from our ores.

Unfortunately the estimate of the metallurgists proved incorrect, and their loss is now running in excess of 5 percent. Unless we are able to improve recovery percentages, Homestake may sustain a loss of nearly $1 million during our 1971 operations.

We are, of course, intensively researching and actively experimenting with two new methods to increase the percentage of recovery. The success of these methods is not yet conclusive, and of course their installation costs more money and more time. By September 1971 metallurgical recovery had dropped to 89.7 percent compared with 95.0 percent for the year 1970. The loss resulting from mercury removal is intolerable.

Despite higher gold prices in 1971, yet another very serious economic loss has confronted Homestake. The grade of our ore mined in 1971, for reasons not as yet fully determined, has dropped substantially below the grade mined in 1970 and much lower than our budgeted estimates for this current year. Unless unlikely improvements in grade occur in the remainder of 1971, our loss from this phase of our operations may well run in excess of $1 million. In addition to these very serious problems confronting management, we face an added increase in costs of $300,000 for an automatic raise in our union contract for wages which becomes effective December 1, 1971, unless the

President's wage freeze order is extended beyond November 12, 1971.

It should also be noted that Homestake has agreed to advance in 1971, through the month of September, $70,000 to the sanitary district to enable that agency to contract for a portion of the engineering services necessary in the planned construction of the Centennial waste stabilization pond. These sums will eventually be credited against Homestake's overall pro rata cost of this project. In addition, Homestake has already paid the sum of $24,865 for one-half the cost of acquiring 204 acres as a portion of the Centennial site. Homestake has also guaranteed bank loans for the Lead-Deadwood Sanitary District #1 to enable the district to pay the other half. Also during this year additional costs were incurred by Homestake and include company staff time and substantial fees paid for an independent engineering study of the feasibility of the Crow Creek alternate proposal.

At this point I should mention the fact that a few ranchers living in the vicinity of the Centennial pond site have formed what they call the "Save Centennial Valley Association." They have protested the location of the stabilization pond at the Centennial site chiefly because they fear that there will be leakage from the pond which will contaminate the underground water sources which supply their domestic wells and stock-watering wells. Secondarily, in general terms, they complain about disturbing the environment and beauty of Centennial Valley. On this point simply let me say that we appreciate the fact that ranchers who cannot profess to be trained engineers, hydrologists or geologists might exhibit some concern over this point. However, competent engineers who have studied the project in their considered opinion believe that the pond and dam can be so constructed by good engineering procedures that there will be no problem causing leakage from the waste disposal pond.

But even assuming there is some small leakage, the considered opinion of experts is that any water so leaking will be devoid of any toxicity from either mercury, cyanates, resites, CN, or coliform bacteria, which would in any way degrade the quality of their domestic wells, either for human or livestock consumption. In fact, Mr. Floyd Matthew of the Brade Engineering Company, who is an expert on water pollution, having worked in this field for many years, is of the opinion that if there were any leakage the ranchers in the area should be delighted since it would put an added charge of water into the aquifer and increase the capacity without degrading the quality of their wells.

Of course the plans for the project include monitoring of wells after construction in the vicinity of the pond to determine whether there has been any degradation of their existing water supply. Of course if any coliform bacteria are detected, Homestake, I am sure, is still solvent enough to purchase chlorinators at an approximate cost of $150 each for any ranchers in the immediate vicinity whose domestic water supply might show signs of contamination. Even the waters of Whitewood Creek today with their present discharges are so nontoxic that neither I nor my Chief Counsel, nor my Public Relations Director, nor Mr. Floyd Matthew had any reluctance or hesitancy in drinking water taken from Whitewood Creek at a recent meeting of businessmen held in the Lead-Deadwood area. The sands, of course, had been filtered out of the water, since obviously no one wants the abrasive effect of particles of sand on their teeth. The water was crystal clear. I have some with me today and would like to again repeat the experiment with some of my associates.

If you will give me just a moment, I will show you some of this water.

This is some of the water taken from Whitewood Creek just in the vicinity of the town of Whitewood and it has settled now so that the silt is in the bottom, but if we shake it up, why, that is how it looks and that is the way the stream looks.

Now, I have with me another bottle, same water, same place. This has been filtered and because in the time involved I don't trust the coliform bacteria it does have some chlorine in it. So I shall drink some of this water.

Any volunteers?

MR. KELLAR: Yes, sure.

MR. STEIN: If we are going to see Mr. Kellar drinking some water, this is worth the price of admission. (Laughter.)

MR. KELLAR: I don't like an aqueous diet completely. I thought you would have a fried catfish for me from the Oahe.

MR. HARDER: We are short of fish. They can't live in this water.

Of course if there are any others who would like to sample it, we are quite free and willing with our water here. I don't know whether you people ought to check up and see who caters this water supply around here or not, but there is not much difference in it as far as I know.

Anyhow, proceeding, in this connection I should also comment on the fact that we have recently taken samples from a number of wells of ranchers whose properties adjoin Whitewood Creek. Analysis of these samples showed no cyanates, CN, or coliform bacteria.

Interesting, too, is the fact that for the past six months we have been conducting a rabbit experiment in Deadwood. A young fellow, at our request, has several pens of rabbits. One pen he has been giving pure tap water for drinking purposes. Another pen was given water directly from Whitewood Creek at a location approximately a half-mile below the point of discharge from our mills which is adjacent to where the young man lives. Another pen was given a water containing 3 ppm of free cyanide, CN. This was made up solution, so all of the ppm were 3 CN. The other, I am sure, is not all. Another pen was given double that dosage or 6 ppm of free CN made up solution of all pure cyanide. Then finally one rabbit was isolated in a pen and given 500 ppm of free NACN, which is the highly toxic compound put into our leaching tanks in our cyanide process at the start of this gold extration operation in the treatment process. Bear in mind the fact that the discharge from the plant after the treatment process is considered by us to be nontoxic. Most remaining CN is in the form of very low toxicity cyanates with only a very small residual amount of free CN which is the toxic variety. This is the same kind of discharge water to which I referred that was drunk by individuals at our earlier meeting and just now. It is also the same water consumed by the rabbits in Pen #2. It has a total CN content of 1.5 to 5 ppm.

The rabbits have thrived. In fact, they have raised several litters of young, who in turn are drinking the solutions to which I have above referred except for the high strength free NACN solution. After six months they continue to be healthy rabbits with no sign of disability. What we do not understand is the fact that the rabbit that was taking the highly toxic solution did not meet death shortly after the first intake of this sample. However, the rabbit lived quite successfully for approximately five months. By then we thought he had performed so nobly we took him off the experiment.

MR. STEIN: You are not suggesting, Mr. Harder, that that rabbit you isolated also raised several litters, are you? (Laughter.)

MR. HARDER: No. In fact, that is one thing that rabbit did not do. (Laughter.) We certainly would not allege that something must not have happened to that rabbit. We are amazed that he lived.

I now come to a proposal made by EPA to which Homestake has most strenuous objection. Several months ago, the EPA Regional Office in Kansas City, through Mr. John Rademacher, suggested that it would be desirable to construct a temporary facility diverting 80 percent of the waters of Whitewood Creek into a much smaller watershed called Crow Creek. We advised him that we would thoroughly explore his suggestion and we have done so.

The proposed Crow Creek project would cost Homestake an estimated $400,000, and insert there "exclusive of land." The installation would necessitate building a dam 35 feet high by 1,500 feet long, would involve considerable pipe, would involve the acquisition of at least 250 acres of land. In any event, the storage capacity at this particular location would be limited to about two years. The entire problem will be resolved by the construction of the Centennial project which was scheduled for completion in November 1973. The Crow Creek project, at a very burdensome cost to Homestake, would save only two years or less in time over the final desirable solution of the Centennial project. We believe this interim project would be a complete waste of time and money, particularly in view of the fact that there is no credible proof of any imminent danger to human health from the discharges that have created no specific problems in this area during 70 to 100 years of past practice.

Homestake engaged the independent engineering firm of Bell, Galyardt, and Wells of Rapid City to research and study the feasibility of the Crow Creek project. Jim Rouse, an engineer for the EPA, believes this project could be completed for a lesser cost. Both Bell and Homestake engineers believe that he has oversimplified the problem. We believe that Bell and our own engineers, with full knowledge of local conditions, are in a better position to judge the cost of the project than one not familiar with the area.

We have continued to study the Crow Creek proposal. We believe that it would impose an unwarranted expense upon Homestake Mining Company for a temporary and partial stop gap measure that does not offer any substantial benefits comparable to its cost and the slight saving in time. Further, it does environmental damage to an additional area.

Our engineers are studying the possibility of utilizing the channel of Crow Creek itself, as proposed by Rouse, as the point of ingress for the waters of Whitewood Creek to the temporary lagoon on Crow Creek. If pipe were necessary for this purpose, it would increase the estimated cost I projected above. The engineers are not at all convinced that channel flow is a feasible method to handle the intake of Whitewood Creek waters. The tailings--and I have changed "may" to "will" based on more recent information given to me by the engineers--the tailings will build up by sedimentation before the waters ever reach the lagoon--strike out "if" and insert "since"--since the gradient does not provide sufficient velocity. This would involve flooding and damage to additional acreage without solving the problem.

We have made offers to landowners for land acquisition, but no one has accepted or made a counteroffer. In fact, two landowners have said they will not permit their land to be used in the project under any circumstance.

A point I wish to make is that in the Black Hills area, with its bitter winter, cold temperature, and frequent snows, contractors in construction projects involving compacted dirt—handling are limited to a very short season. Thus even if construction of the temporary Crow Creek project were economically feasible, which it is not, it would certainly be late fall of 1972 before the waters of Whitewood Creek could be thus temporarily diverted. Thus the gap in time between completion of the Crow Creek facility and the permanent Centennial project is about 18 months, during which, if plans proceed on schedule, the more desirable Centennial site would be well on the way toward completion.

A question: What, then, is the harm in permitting Whitewood Creek waters to run their customary course for the short period of time which would be saved, at substantial economic and environmental waste, if the Crow Creek diversion was built? Certainly no harm will occur from the toxicity of the waters either by virtue of cyanates, CN or residual mercury. The amount of sediments carried in the form of tailings during this brief period of time should be regarded by the Corps of Engineers as insignificant in the overall sedimentation problem of the Oahe Reservoir. The Corps estimates that Oahe Reservoir will not be filled with sediment for a period of time ranging from 250 years at Gavins Point to over 1,000 years at Fort Peck, although after 100 years there may be some sedimentation enchroaching upon some lands used for other purposes. Recent studies of the sediments carried by western waters in western South Dakota by Corps of Engineers show that the following rivers in western South Dakota: the Moreau, the Cheyenne, the Bad, the White and the Grand, carry each year approximately 28 million tons in sediments. Homestake tailings deposited in the Whitewood, thence into the Cheyenne, approximate a million tons per year. Thus for a further period of two years Homestake industrial wastes in the form of tailings would contribute only 1/28th of the deposits being carried each year into Missouri River reservoirs. This amount is not significant in the life period projected for this reservoir system.

Furthermore, with reference to deposition of raw sewage for the brief span of the period above mentioned, one cannot overlook the fact that for over 100 years this practice has continued without damage or harm to human health. It might be well to point out that the mere fact that Homestake deposits tailings which turn Whitewood Creek into a black or gray stream, and also the Belle Fourche, has been a very effective deterrent to anyone desiring to drink these waters, be it rancher or visiting tourist. Furthermore, as noted heretofore, while the cyanates and cyanide in Whitewood Creek waters are not in sufficient toxicity to be harmful to humans or animals, nevertheless they are toxic to lower aquatic forms of life; hence, undoubtedly the minimal amounts of such compounds in the waters have a beneficial effect in destroying bacteria. If Homestake Mining Company were not putting its tailings into the stream, the waters of Whitewood Creek might be clear but they would be loaded with raw sewage and visitors to the area unaware of that fact might be inclined to drink these waters. At any rate, the few ranchers living along Whitewood Creek and the Belle Fourche River years ago decided to obtain their domestic water supply from wells.

Summarizing on Crow Creek, I would use the old cliche, "Haste makes waste." Certainly there is nothing in the facts to justify the imposition upon Homestake of the burden of spending hundreds of thousands of dollars, which it can ill afford and which could well contribute to an intolerable economic situation leading to a no-profit position, for the sole purpose of gaining a possible two years or less in time over the final solution at

Centennial.

Since the purpose of this conference is to study not only mercury pollution in the waters of Whitewood Creek and the Cheyenne River, but also to consider mercury occurring in the other rivers of western South Dakota, I think it pertinent to make a few observations on the subject of mercury. The event which triggered the hue and cry in this country over mercury pollution was the Minimata incident in Japan where a plastics factory discharged methylmercury into a stagnant, algae-infested bay, the habitat of many shellfish. This was the principal diet of Japanese living in that area and a number of deaths occurred traceable to this food source.

I have read a considerable volume of literature on the subject of mercury. I have not had called to my attention any reliable report of damage to human health in the United States from eating mercury-bearing fish. The Almagordo, New Mexico, incident, oft-quoted, relates not to mercury in fish but to damage to human health attributable to eating hog meat which had become contaminated with mercury because the swine ate mercury-treated seed grain. This is an entirely different situation.

The tolerance level set by the United States for mercury in fish is 0.5 ppm. Significantly, the Swedes, who have engaged in thorough mercury research since 1960, long before intensive mercury research became the vogue in America, have surprisingly enough set a tolerance level twice that of this country, i.e., 1.0 ppm.

I had planned a few side comments here, but that ball has been rolled around so much and so thoroughly I am going to let it lay. I just want to express that there are different viewpoints.

In the early summer of 1970 some 15 fish of varying species were caught in the Cheyenne arm of the Oahe Reservoir and in the Oahe Reservoir. Analysis by Federal officials disclosed that these fish contained mercury in quantities varying from 0.08 to 0.35 ppm. Later that summer one pike was caught in the Oahe Reservoir, which, on analysis, showed about 1.0 ppm. I believe one or two other fish were caught which showed a similar amount, but one of them was in the Angostura Reservoir in the southern Black Hills, which has no connection with the Homestake drainage system. They need a fish ladder to get in. I have yet to see in the scientific literature on the subject any statement that the mercury in fish flesh in South Dakota is methylmercury. Is the mercury found in these fish one of the relatively nontoxic mercury compounds? I am simply saying that much more research is necessary to arrive at a sound conclusion as to whether the mercury in fish, be it from the Oahe Reservoir or in ocean tuna or in swordfish, can be credited to methylmercury, a known toxic mercury compound.

Geologists have long been aware of the fact that mercury is found in the soils of various countries throughout the world. They also know that mercury may occur at higher levels in lignite coals and in shales than in most other rocks. Some of the rivers of western South Dakota besides the Cheyenne cut through lignite coals and through broad areas of shale. Based on this general knowledge, Homestake requested our chief geologist, Olin Hart, to take samples of both soils and water in various parts of the western States where there was no industrial contamination. His map showing the location where these samples were taken and the resulting analyses are attached to my statement. Significantly, there is a similar pattern to the samples which he took elsewhere and the samples reported by the State of mercury content in water at certain points along the Belle Fourche River.

I ran into a problem of labs, too. I will make a side comment here. We made the mistake of sending it to different labs and we got variations from 1, to one sample as high as 800. I don't know. Generally the variations were less than that, say 4 to 20, but a real tremendous variation. I will tell you my conclusion. One of the labs I sent it to was Cordero Mercury Mining Company. I said to myself, we know how to run for gold, they must know how to run for mercury. I think they do. But I am afraid that their lab might be dusted up a little bit (laughter) because every sample of theirs was way high. And this brings up to me a little point that I guess everybody here knows what--maybe not everybody, so I will tell it--the driest martini in the world is the 1.0 ppm, which is one jigger of vermouth in one tank car load of gin, and 1.0 ppm is a thousand; one jigger in a thousand of those. Now, I am not going to argue with the scientists that the technique isn't available to make those distinctions. But believe me, it puts a burden on cleanliness in the laboratory, care in handling samples everywhere along the line. So I think this is what happens.

MR. STEIN: Mr. Harder, let me make a point. We have had, developing evidence in cases through the country, the same problem. I want to give you what we do. We split samples. We do not take the results, any results, from a single lab, but only when we have two labs that are quite a distance apart and' don't know about the other one. They send, not to each other but to us, independent reports and only when these reports coincide do we go with that result. And I don't think there is any shortcut to that procedure.

So in other words, what I am saying is, I agree with you, but we don't put out any results until at least two labs have come in with the same numbers.

All right.

MR. HARDER: Well, thank you. As a geologist and mining engineer scientist I am aware of sampling problems. We have a gold ore that is only 10 ppm and that takes care of the well.

Anyhow, to proceed.

Homestake conducted another research project in the fall of 1970 by having one of its contract miners go fishing in the waters of Keyhole Dam in Wyoming, Orman, and Shadehill Dam in South Dakota, and Garrison Reservoir on the Missouri River in North Dakota. We sent these fish to the Dow Chemical Company in California for analysis, and the results of their report, attached hereto, show that these fish ran from 0.12 to 0.51 of mercury, more or less the same pattern as those fish taken in the Cheyenne arm of the Oahe Reservoir except for the one or two pike above noted. Of more than passing interest is the fact that a trout caught by our chief counsel, Mr. Kellar, in front of his home in Spearfish Canyon in the crystal-clear waters of Spearfish Creek, far from any source of industrial contamination, also showed on the Dow analysis a mercurial content of 0.24 ppm.

I submit that in the light of present known research there is no cause for a wave of apprehension over the potential damage which might occur to human health from eating fish from the waters of South Dakota.

Undoubtedly in the sediments of Whitewood Creek and in the crevices of the rocks in that stream, there are deposits of mercury both native and manmade. A large quantity of such mercury undoubtedly has as its source early-day placer mining operations nearly 100 years ago in Whitewood Creek and its tributaries. Some was also deposited as a result of mining and milling operations of a number of mines which operated decades ago but which have long since gone out of business.

Before concluding, I should like to show the conferees several colored photographs which I think may be of interest. And I have a set here, I will just pass them down the line to the panel for their inspection at their leisure, if they have any.

And then I have a couple here of Centennial Valley itself. They are keyed on the backside if you want to know what they are. And this group I have shown you now are the pictures of the mouths of rivers of South Dakota as they flow into the Oahe Reservoir to show that rivers other than the Cheyenne have a great silting problem at their mouth. They carry great loads of silt and deposit it.

Now, if I may--Ken, maybe you could bring those pictures up and I could hold them here. I don't know that they add a great deal, but they are here for inspection and I think you are probably too far away to see them. They show the Centennial Valley site area. I think we will just hold them aside and if you would like to look at them later you can.

I show you the photo of Centennial Valley site and in contrast several photos of surrounding much more valuable--I think this is right, I don't think they gave me all these photos here so I don't really have that many.

MR. KELLAR: That is included in the large one there.

MR. HARDER: The land for the Centennial site has been classified by the Soil Conservation Service in the main, except for about 50 acres, as Class 6 and 7 lands. The lowest land classification in the value scale is Class 8.

I also show you colored photographs of the point of entry of various western South Dakota streams into the Oahe Reservoir to illustrate that sediments in volume are carried by Nature in every western South Dakota river, which you are now looking at.

Now I can pass along to you the Centennial Valley photos that are coded on their back.

(The above-mentioned photographs, marked Exhibit 2, are on file at EPA Headquarters, Washington, D. C., and the Regional Office, Denver, Colorado.)

MR. HARDER: Summarizing, I wish to make an urgent appeal to this conference to recommend prompt implementation and completion of the permanent waste stabilization pond at the Centennial site. While the EPA has reported that the Crow Creek temporary project is technically feasible, I urge the EPA to abandon its proposals in this direction because it would impose an unnecessary and in our opinion unwarranted financial burden on Homestake without significant compensating results. I presume any dam is technically feasible, including Aswan, if enough dollars are available for the project. The Crow Creek proposal does not have economic and environmental balance.

We had anticipated receiving final approval from EPA by July 1, 1971, including approval for a grant in the amount of 30 to 33 percent of the cost. Our latest information is that such final approval may be forthcoming, but not before January 1, 1972. Any delays, even those inherent in this hearing, further complicate and impede prompt and final solution of the waste disposal problem. I have commented on the obvious reasons why the bond election has had to be postponed. Furthermore, acquisition of lands needed for the Centennial site have been delayed because negotiations with ranchers owning necessary property have proved fruitless. The Lead-Deadwood Sanitary District #1 may well have to exercise its condemnation powers granted by statute in order to obtain the necessary site. However, the trustees of the sanitary district have received legal advice from their counsel that such proceedings cannot be pressed to conclusion or even initiated until EPA has given its final approval to the Centennial project.

Final engineering, detailed plans and specifications have been delayed because the sanitary district cannot make financial commitments for the performance of such work until it can be assured that the waste stabilization pond will be built at the Centennial site.

I wish to let the conferees know that our own Homestake engineers, in conjucntion with the independent engineering firms who have studied the project, have examined numerous alternate sites. None of them meet the requirements of the problem. For the benefit of conferees unacquainted with the topography adjacent to Lead and Deadwood and down Whitewood Creek, I wish to advise them that this is a very rough, mountainous terrain with narrow canyons. There simply isn't any room in any of these canyons to store tailings for a sufficient number of years to solve the problem. Any dams constructed across these narrow canyons would be highly expensive, and would provide little storage capacity.

Homestake and the Lead-Deadwood Sanitary District are most desirous to promptly and expeditiously solve this waste problem so as to avoid rising costs from future inflation. Despite the recent action of the administration to halt inflation and to improve the economy, no one, I believe, can foretell with certainty whether or not the years immediately ahead will see further cost rises. Certainly they are not expected to decline. Several prominent officials of EPA have repeatedly stated that it is not their intent to close down businesses. I plead merely for a rule of reasonableness which will enable us to solve the waste problem in an orderly, competent and reasonably short period of time in line with the projections for the completion of the Centennial pond. We do not think this is asking too much to solve a problem, the origination of which goes back nearly a century.

I can understand and sympathize with the ranch owners who are reluctant to see the Centennial area used for the proposed waste treatment lagoon and disposal project. In their circumstance it is possible I might feel much as they do. We just have not been able to find any other site that is economically or technically acceptable. No one else has been able to suggest such a site. Even if such another site could be found, we would likely find a new set of objectors, unless it was on Homestake land. Homestake site possibilities were carefully reviewed and rejected early in the studies for technical, economic, and safety reasons.

We can find no other site. We believe the Centennial area can be used without danger or harm to anyone. We urge approval of the project as planned. The environmental gains far outweigh any possible losses. Rejection of the project jeopardizes the future of the communities of the Lead-Deadwood area. The few who may be displeased with use of the Centennial area are far outbalanced by many thousands who will benefit from a clean Whitewood-Belle Fourche-Cheyenne River system and a viable Lead-Deadwood community supported by a living Homestake mine.

We have just received the EPA report on the Cheyenne River system in western South Dakota. We note in it questions-- and I inserted an "it," I think it is inserted in your copies-- raised by other heavy metals such as arsenic, zinc, and copper. We request permission to make a later reply to those problems when we have had time to study the report and the questions it raises.

(The above-mentioned attachments follow:)

HOMESTAKE MINING COMPANY

INTER-DEPARTMENT COMMUNICATIONS

TO Mr. J. O. Harder

DATE November 30, 1970

FROM Olin M. Hart

SUBJECT Mercury Sampling on South Dakota Drainage Systems

REFERENCE

Mercury samples collected on the drainage systems across Western and Central South Dakota are listed below. Locations, type of sample and analytical results are posted on the accompanying South Dakota State Highway map and overlay.

Mercury analysis were run by Coors Spectro-Chemical Laboratory, Golden, Colorado and Cordero Mining Company, Winnemucca, Nevada. Mercury analysis in fish were made by Dow Chemical Company, Pittsburg, California.

Water Samples

All water samples collected in new Teflon 16 oz bottles with narrow mouth, Teflon top. 1 ml. HNO_3 added to each sample.

Analysis for mercury in water samples run by Coors Spectro-Chemical Laboratory, Golden, Colorado.

Sample No.	ppb Hg	Sample Location
No. 1	0.4	Belle Fourche River 75 yds. west of bridge on S. D. Highway 79 just south of Newell. Collected stream center. Banks shale. Homestake tailings in stream. Time 8:30 A. M. August 27, 1970
No. 2	1.2	Indian Creek Sample taken under bridge on S. D. Highway 79 south of Newell. Stream canaled, silty as though from irrigation runoff. Banks shale. Time 8:45 A. M. August 27, 1970
No. 3	2.0	Moreau River Under bridge on secondary road north of Maurine on U. S. 212. River stagnant, only a string of ponds. Shale banks. Time 10:05 A. M. August 27, 1970
No. 4	<0.1	Moreau River Under bridge on S. D. Highway 73 south of Usta or north of Faith. River nearly dried up, only a string of ponds. Shale banks. Time 11:00 A. M. August 27, 1970

Sample No.	ppb Hg	Sample Location
No. 5	1.2	Grand River Under bridge on S. D. Highway 73 at Shadehill only a few miles below Shadehill Dam. Stream flowing. Shale banks. Time 11:55 A. M. August 27, 1970
No. 6	1.6	Moreau River Under bridge on S. D. Highway 65 north of Dupree. River not flowing, nearly stagnant, only a string of ponds. Time 1:20 P. M. August 27, 1970
No. 7	0.7	Grand River Under bridge on S. D. Highway 65 south of McIntosh. Stream flowing. Shale banks. Time 2:15. P. M. August 27, 1970
No. 8	1.3	Missouri River - Oahe Dam Southeast shore under bridge on U. S. Highway 12, northwest of Mobridge. Shale shorelines. Time 3:35 P. M. August 27, 1970
No. 9	1.9	Missouri River - Oahe Dam 1/4 mile east of bridge on U. S. Highway 212 on south shore. Shale banks, glacial surface sheet wash of granitic type rock. South shore active with landslides. Time 5:05 P. M. August 27, 1970
No. 10	0.3	Cheyenne River Taken near stream center from stream gauge ladder on bridge piling on S. D. Highway 63 south of Eagle Butte Homestake tailings in stream. Time 1:20 P. M. August 28, 1970
No. 11	0.6	Oahe Dam Spill race below powerhouse along south shore just north of Pierre. Reservoir banks are nearly all shale. Time 8:30 A. M. August 28, 1970
No. 12	0.3	White River Under bridge on U. S. 83 south of Murdo. Stream nearly dry, only a string of ponds. Time 11:30 A. M. August 28, 1970
No. 13		White River Under bridge on S. D. Highway 30 A east of Interior. Stream nearly stagnant, only a string of ponds. Sample used up before results obtained. Time 4:50 P. M. August 28, 1970
No. 14		Cheyenne River 1/2 mile below bridge on U. S. 90 at Wasta (west of Wall). Taken stream center. Sample used up before results obtained. Time 5:50 P. M. August 28, 1970

Sample No.	ppb Hg	Sample Location
No. 15	2.9	Belle Fourche River Under bridge on secondary road north of New Underwood, south of Hereford. Homestake tailings in stream. Time 6:45 P. M. August 28, 1970
No. 16	2.2	Missouri River Spill race below powerhouse on east shore. Shale banks on dam. Time 10:00 A. M. August 28, 1970
No. 17	1.1	Cheyenne River Under bridge on S. D. Highway 34 between Billsburg and Howes. Homestake tailings in stream. Time 2:45 P. M. August 28, 1970
No. 18	2.3	Belle Fourche River Under bridge on S. D. Highway 34 east of Bear Butte. Homestake tailings in stream. Time 7:30 P. M. August 28, 1970
No. 19	2.9	Orman Dam Outlet of the Belle Fourche Reservoir. Time 8:35 A. M. August 29, 1970
No. 20	2.8	Tap Water Geology Department darkroom. Time 7:45 A. M. September 5, 1970
No. 21	2.3	Cutting Mine Water Taken at pump. September 3, 1970
No. 22	3.6	Whitewood Creek Test pond site in lower Deadwood. Test pond influent at discharge of hose into tank from pump in creek. Time 4:00 P. M. September 3, 1970
No. 23	5.0	Whitewood Creek Test pond site in lower Deadwood. Test pond effluent after aeration on riffles. Taken from stock tank. Time 4:00 P. M. September 3, 1970
No. 24	2.9	Whitewood Creek 500 feet south of Shamrock Drive-in at Pluma along U. S. Highway 385. Time 7:20 A. M. September 5, 1970

Silt Samples

Silt samples were collected in plastic sandwich bags (baggies) from bottom muds in drainage systems. Samples were air dried for 72 hours and split into two samples. Analysis for mercury were run by Coors Spectro-Chemical Laboratory, Golden, Colorado and Cordero Mining Company, Winnemucca, Nevada.

Sample No.	Coors ppb Hg	Cordero ppb Hg	Sample Location
1N	ND< 1	125	Riley Pass Claim S. D. Collected from small lignite seam near the two small lignite stock piles. October 13, 1970
2N	ND< 2	44	Riley Pass S. D. Collected from small settling pond going west from Riley Pass. Sample came from inlet end and was taken below water line. The pond appears to have collected material from the lignite mining operation. Water was muddy with no vegetation. October 13, 1970
3N	ND< 1	9	Bowman-Haley Dam N. D. Collected at Point Rec. Area. The sample came from a mud flat point projecting into the reservoir. Taken just below water level. (Farming area - wheat and hay). October 13, 1970
4N	9.8	25	Gascoyne N. D. Lignite sample collected from material fallen from truck hauling across U. S. 12. October 13, 1970
6N	ND< 1	14	Grand River S. D. Collected 100 yards east of S. D. Highway 73 bridge. Sample from lee end of grass covered bar below water line. Water flowing but muddy with no vegetation. October 13, 1970
7N	ND< 1	32	Grand River S. D. Collected 50 yards west of S. D. Highway 65 bridge. Sample from lee end of sand bar below water level. Water flowing rather swiftly but muddy with no vegetation. October 14, 1970
8N	ND< 2	45	Moreau River Collected 50 yards east of S. D. Highway 65. Sample from mud flat near water level. Water not flowing, consists of a string of ponds along river bed.
9N	ND< 1	32	Moreau River Collected 50 yards west of S. D. Highway 73 bridge. Sample from sandy mud flat below water level. Water flowing slowly, muddy with no vegetation. October 14, 1970

Sample No.	Coors ppb Hg	Cordero ppb Hg	Sample Location
10N	ND <1	25	Moreau River Collected 100 yards north of secondary road bridge north of Maurine. Sample taken from mud flat beneath water line. Thin mud layer above sand. Water flowing but muddy with no vegetation. October 14, 1970
11N	9.8	18	Orman Dam Collected from mud flat, near water level, several hundred yards north of dam. October 14, 1970
12N	ND <1	30	Indian Creek Collected 150 yards east of bridge on S. D. Highway 79. Sample from below water line along stream bank. Water flowing and clear with some vegetation. October 14, 1970
13N	ND <1	990	Belle Fourche River Collected 200 yards east of bridge on U. S. Highway 79. Sample from narrow, fine grained, mud flat at edge of river. Homestake tailings in stream, water rapidly flowing. October 14, 1970
14N	9.1	720	Belle Fourche River Collected 100 yards south of bridge on S. D. Highway 34. Sample from below water level along sand bar. Homestake tailings in stream, water rapidly flowing. October 14, 1970
E1	ND <1	24	Beaver Creek N. D. Under bridge at town of Linton, U. S. Highway 83. October 14, 1970
E2	ND <2	18	Beaver Creek N. D. Under bridge 3.7 miles west of Linton and 0.5 miles south. October 14, 1970
E3	ND <1	16	Beaver Creek inlet N. D. Under bridge 13.6 miles west of Linton and 4.1 miles south. October 14, 1970
E4	ND <1	10	Lake Pocasse S. D. Under bridge near town of Pollock. October 14, 1970 (From spit sandbar)

Sample No.	Coors ppb Hg	Cordero ppb Hg	Sample Location
E5	ND <1	27	Lake Pocasse S. D. Next to overflow gates from Lake Oahe. October 14, 1970
E6	ND <1	25	Lake Oahe S. D. Next to overflow gates to Lake Pocasse. October 14, 1970
E7	ND <2	18	Feeder stream into Lake Pocasse 2 miles south of S. D. Highway 10 and 6 miles west of U. S. Highway 83. Intermittent stream; collected from sump pocket in stream bed. October 14, 1970
E8	ND <2	30	Lake (no name) feeding into Spring Creek 2½ miles south and 1 mile east of town of Herreid, S. D. October 14, 1970
E9	No sample		Vegetation from same locale as E8. October 14, 1970
E10	ND <2	17	Spring Creek S. D. Under bridge at U. S. Highway 83 0.5 miles south of town of Herreid. October 14, 1970
E11	ND <2	12	Spring Creek S. D. Under bridge 0.5 miles south of town of Artas on S. D. Highway 105. October 14, 1970
E12	ND <2	20	Outlet stream of Lake Campbell S. D. 2 miles west and 2 miles, north of town of Mound City. Under roadway. Stream intermittent. Flows only when lake is full or water released. Sample from mud under bridge. October 14, 1970
E13	ND <2	36	Flowage area of stream from Swan Lake S. D. At end of county Highway 238, 6 miles west October 15, 1970
E14	ND <3	29	Stream from Swan Lake S. D. Under bridge on U. S. Highway 83, 3 miles east and 1.5 miles south of town of Akaska. October 15, 1970
E15	ND <40		Vegetation from location of E14. October 15, 1970

Sample No.	Coors ppb Hg	Cordero ppb Hg	Sample Location
E16	ND <2	34	Outlet stream area from Swan Lake S. D. Under bridge on county Highway 228, 2 miles east of town of Lowry. Sample from stagnant pool of stream bed. October 15, 1970
E17	ND <2	27	Swan Creek inlet to Swan Lake S. D. Under bridge on county Highway 241, 8 miles east of town of Lowry. October 15, 1970
E18	ND <2	24	Little Cheyenne Creek S. D. Under bridge on road 2 miles west of U. S. Highway 83 and 7 miles north of intersection of U. S. 83 and U. S. 212. October 15, 1970
E19	17.0	30	Lake Hurley S. D. At outlet to Little Cheyenne Creek. October 15, 1970
E20	ND <5		Vegetation from Little Cheyenne Creek 100 ft. from outlet of Lake Hurley. October 15, 1970
E21	ND <3	36	Okobojo Creek above Sully Lake S. D. Under bridge from sump pool 3.5 miles west of U. S. Highway 83 and 3 miles north of town of Onida. October 15, 1970
E22	ND <4	18	Okobojo Creek Under bridge from stagnant pond at county Highway, 5.5 miles west of U. S. Highway 83 and due west of Onida. October 15, 1970
E23	ND <2	17	Lake Sully S. D. 200 ft. into lake from spillway. October 15, 1970
E24	21.5	15	Okobojo Creek above Okobojo Lake Under bridge on county road 15.5 miles west of U. S. Highway 83 and 4.5 miles south of Onida. October 15, 1970
E25	ND <2	17	Okobojo Creek below Okobojo Lake At pool where creek crosses county road 17.5 miles west of U. S. Highway 83 and 5 miles south of Onida. October 15, 1970

Sample No.	Coors ppb Hg	Cordero ppb Hg	Sample Location
E26	ND < 1	23	Medicine Creek S. D. Near RR bridge north of creek intersection with S. D. Highway 34, 13 miles southeast of city of Pierre. October 16, 1970
E27	ND < 2	15	Medicine Creek S. D. Under bridge on U. S. Highway 14, one mile east of town of Blunt. October 16, 1970
E28	ND < 1	18	Feeder to Medicine Creek Stagnant pool under bridge on county road 1.5 miles south of town of Harrold. October 16, 1970
E29	ND < 2	11	Evaporite sample Medicine Creek S. D. Under bridge at county road 13-1/3 miles east of town of Onida. October 16, 1970
E30	ND < 2	17	Damp mud. Under bridge in Chapell Creek 10.5 miles south of town of Harrold. October 16, 1970
E31	ND < 1	28	Dry sample from in front of culvert under county road at south Chapell Creek 13-1/3 miles south of Harrold. October 16, 1970
E32	ND < 3	38	Evaporite sample. Chapell Creek Under bridge on S. D. Highway 34, 22 miles east of Pierre. October 16, 1970
E33	ND < 3	42	Stagnant pool under bridge 1 mile south of Mac's Corner, S. D. October 16, 1970
E34	ND < 1		Evaporite from same locale as E33. October 16, 1970
E35	ND < 2	23	Under bridge on Elm Creek S. D. S. D. Highway 34 8 miles east of town of Lee's Corner. October 16, 1970
E36	ND < 2	20	Crow Creek S. D. Under bridge on S. D. Highway 45, 4.5 miles south of town of Gann Valley. October 16, 1970

Sample No.	Coors ppb Hg	Cordero ppb Hg	Sample Location
E37	ND < 3	30	Stagnant pool in Smith Creek S. D. Under bridge on S. D. Highway 45, 10 miles south of Gann Valley. October 16, 1970
E38	ND < 2	24	Evaporite from same locale as E33. October 16, 1970
E39	ND < 1	22	Lake Bedashosha S. D. Waterway between the lake and Missouri River. On dirt road 1.1 mile east of S. D. Highway 47 and 6.5 miles south of S. D. Highway 34. October 16, 1970

Fish Samples

Fish collected by Kenneth C. Kellar

Fish samples were packed in ice and shipped to Dow Chemical Company, Pittsburg, California for mercury analysis.

Species	Location	Date Caught	ppm Hg
Carp	Orman Dam	10-21-70	0.12
Carp	Orman Dam	10-21-70	0.30
Sucker	Orman Dam	10-21-70	0.14
Carp	Garrison Reservoir	10-13-70	0.16
Northern Pike	Garrison Reservoir	10-12-70	0.51
Walleyes (2)	Garrison Reservoir	10-13-70	0.38
Walleyes (2)	Shadehill Reservoir	10-14-70	0.26
Catfish (2)	Shadehill Reservoir	10-14-70	0.26
Perch (2)	Key Hole Reservoir	10-20-70	0.18
Walleye	Key Hole Reservoir	10-20-70	0.18
Trout	Spearfish Canyon	10-24-70	0.24
Trout	So. Fork, Rapid Creek	10-4-70	0.07

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Study Hits Mercury Scare

Human Levels Have Declined

MINNEAPOLIS — (AP) — Recent concern over mercury levels in fish and lakes may be unwarranted because mercury levels in human tissues have declined, researchers say.

Reporting findings of their study to the annual meeting of the American Public Health Association, the researchers today blamed part of the mercury scare on "emotionalism and ignorance."

Tissues Studied

Their study was done at Saratoga General Hospital in Detroit and involved analysis of tissues taken from human organs at autopsy between 1913 and 1970 and preserved at the University of Michigan in Ann Arbor.

The tissue was taken from the bodies of 59 Michigan residents who had died of causes unrelated to mercury.

The authors said that concern over mercury contamination "had profound social reverberations in the form of mass anxiety leading to . . . action — often with little or no scientific basis — resulting in chaos, fear, and the economic pain of damaged or killed sectors of industry and commerce."

Human Levels

While research has been conducted on mercury levels in fish, little has been done on mercury content of human tissues, they said. It is presumed that high mercury levels result in damage to the central nervous system of human beings.

At the news conference, Dr. Jack Kevorkian, one of the researchers, criticized the Food and Drug Administration for setting a standard of .5 parts per million of mercury in fish as the maximum permissible level.

There are no data to support such a standard, he said, and added that it is based on "emotionalism and ignorance." Sweden permits a level twice as high, he noted.

Two Peaks

The study found that the level of mercury in human tissue, which ranged upward to 34 parts per million, does not remain constant but reaches peaks in early childhood and again in middle age, indicating that it does not accumulate in the body. Tissues were studied from persons ranging in age from the newborn to 81 years.

The researchers also found that there was "an extraordinary degree in mercury content in almost all organs studied, sharper in the early decades of this century, levling ozff recently."

"The facts indicate a gratifying cleansing of the environment, or the absolute reverse of recent 'scare' pronouncements which led to such inexcusable panic actions on the part of authorities who had no factual knowledge for truly sound judgment," authors stated.

'No Problem'

"No matter what levels of mercury are found in any other substance, if human tissue levels are low and remain low under constant surveillance, there is no environmental pollution problem," they said.

They speculated that one reason for the mercury decline was the drastic reduction in use of coal for fuel. Coal smoke has been found to contain mercury.

'Emotionalism' blamed

Mercury levels in human tissues said declining

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Wednesday, October 13, 1971

-Grants Daily Beacon, Grants, New Mexico

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MR. HARDER: We assume that you will keep the record open for additional statements of participants for the usual 30 days?

MR. STEIN: We generally do that for a week.

MR. HARDER: A week?

MR. STEIN: Can you comply with that? Is that possible?

MR. HARDER: Can you comply in a week?

MR. STEIN: How soon can you do it? We want to be reasonable.

MR. KELLAR: Just a moment, Mr. Chairman.

MR. STEIN: How long would you really need for that?

MR. KELLAR: Our expert on this subject who is going to study it says he can prepare and have this--he has to study it first and do some field work, and his report will be ready the first week in November. Is that right?

DR. WURTZ: I will prepare the report the first week in November. I would hope to have it out to Homestake the second week.

MR. STEIN: I tell you what, we will take that report as an exhibit to the record.

(The above-mentioned report, Exhibit 3, is on file at EPA Headquarters, Washington, D. C., and the Regional Office at Denver, Colorado.)

MR. HARDER: I have no more and that ends my statement. I thank you for your patience.

MR. STEIN: Thank you.

Let's see if we have any comments or questions.

I would like to thank you, sir, for a full disclosure, as we always have had from Homestake, and a very candid statement. I think aside from some of the philosophy here we may be rather close to agreement on a solution, and I think that is the secret of our system--that even though we may have differences in philosophy we can generally, through a procedure such as this, under our system with the States and the industry, come up with agreements on what we are going to do on a particular problem.

I do think, while I recognize you might think that your industrial discharges making the waters of the creek black or dirty gray by a high volume of silty tailings in the stream might not, in your opinion, be pollution or might be an indicator for people just to stay away from the stream, that pretty generally the regulatory agencies do think that is pollution.

MR. HARDER: I didn't really think you would accept that statement. (Laughter.)

MR. STEIN: You know, not too many years ago when Sandy Koufax was in his prime as a pitcher, one fellow said he didn't think he was very good, and I guess he was entitled to his opinion, and he says, "You know, that guy ain't got much. All he has got is a fast ball, a curve, and control." (Laughter.)

Are there any other comments or questions?

If not, thank you very much.

MR. HARDER: Thank you.

MR. STEIN: We have five people after lunch and I wonder if it would be possible for us to try to be back here at 1:30.

We stand recessed.

(NOON RECESS)

AFTERNOON SESSION

WEDNESDAY, OCTOBER 20, 1971

(1:30 o'clock)

MR. STEIN: Let's reconvene.

Dr. Hayes.

DR. HAYES: Thank you, Mr. Chairman.

I would like to call on Dr. Charles B. Wurtz at this time, who is the consulting biologist for the Homestake Mining Company.

Dr. Wurtz.

DR. CHARLES B. WURTZ
CONSULTING BIOLOGIST
PHILADELPHIA, PENNSYLVANIA

DR. WURTZ: Mr. Chairman, conferees, ladies and gentlemen.

My name is Charles B. Wurtz. I am a consulting biologist. My residence and place of business are 3220 Penn Street, Philadelphia, Pennsylvania. As a consulting biologist for more than 20 years I specialize in the effect of discharges on aquatic ecosystems.

And I feel a little peculiar at this particular hearing because I think for the first time in my life I am appearing before this Chairman without at least in some small measure being in an adversary position. But I am not in an adversary position. For the first time in my life I have read an EPA report or the biology of it that I admire, and this is hard to come by. There are some things I don't agree with, but I think basically the biology of the report is very good.

I was retained by Homestake Mining Company following a meeting here in Lead, South Dakota, last March to make investigations into the biological problems of the stream system associated with their discharge in both the so-called sand plant and slime plant. The program as I designed it embraced two facets of biology. One, a study of the resident population of organisms living in the streams of the system, and two, a bioassay test to identify the degree of toxicity of the discharged material. I will talk about these separately.

Now, when I speak of the EPA report, I am speaking of that report issued under date of September 1971 related to the pollutional effects of the Cheyenne River system. It has been referred to by other participants here as the black report. I do not like the term. This is the kind of report I am reputed to write and I would rather refer to it as the EPA report.

I admire the report primarily because, although my own reports are not yet complete, my field notes indicate that Mr. Warner and I are practically eyeball to eyeball on our results, and this rather floors me. For example, in those stations where we did in fact both collect--I didn't know that he was working, I presume that he didn't know that I was working there; I was there in early July, he was there at other times. In the Whitewood Creek above its confluence with Gold Run his report indicates he found essentially the same fauna that I did. I think because our collecting methods differ that I have a higher degree of diversity, that is more different kinds.

The same thing holds true for Deadwood Creek above Deadwood.

On the Belle Fourche River--I am not quite sure where his station is located downstream, but it is somewhere in the vicinity of Sturgis--I collected from the Belle Fourche River downstream from the confluence of Whitewood Creek at the Route 79 Bridge. He found nothing. I found three specimens, one damselfly nymph, two beetles. These were adventitious things, I am sure, that drifted in from up the Belle Fourche River and on down past the mouth of Whitewood Creek.

On the Belle Fourche River above its origin or above its confluence with Whitewood Creek, Mr. Warner collected up around a town by the name of Fruitdale, which I avoided, and I collected about three miles above the Route 79 Bridge. I went up above the Whitewood bearing into Owl Creek that comes in from the north. Since that was uncommonly turbid at the time, I went further upstream to the next bridge, I have forgot the name of the community. Where at Fruitdale Mr. Warner found 17 species of organisms, down at the area where I collected I found 20-plus species, so we are quite close there.

In the Cheyenne River at Route 34, where we both collected, his report indicates that he found 14 species. My field notes indicate that I found 13-plus species. So we have come out with a rather remarkable numerical coincidence.

There is one station where Mr. Warner collected where I did not collect and this was City Creek in Deadwood. Now, at that station the report on page 24 says, and I quote:

> The quality of City Creek at Deadwood... was similar to that of Deadwood Creek and Whitewood Creek...Qualitative biological sampling of City Creek revealed the presence of many pollution-sensitive forms. Close quotes.

Now, the biological data collected by Mr. Warner presented in three pages of a table of that report, Table E-1, pages 62 to 64, I looked at those tabular data and Mr. Warner indicates that six species were found in City Creek with an abundance of six per square foot. Now, if he is going to compare this with 26 species in Whitewood and 23 species in

Deadwood, I thought there was something odd about this.

So this morning, being old enough to not be concerned about the stature of a man, I braced Mr. Warner. I thought maybe somebody had shuffled his papers and copied the wrong thing. What he was trying to say on page 24 was, as I understand what he tells me, that City Creek was similar to Deadwood Creek and Whitewood Creek on the basis of the fact that within the physical framework of that stream it was normal, that City Creek, as he describes it, is essentially a small drainage ditch, it would not be expected to have the diversity that you would find in the larger streams.

But anyway, he did in that sense satisfy my objection to this apparent discrepancy. But I bring it to the attention of the panel so that when they read this and compare this with the tabular data they bear this in mind.

I would like to return to the second part of my investigations in the interest of Homestake Mining Company and this was a bioassay study. This study was done at the sand plant in the garage right along the road there. We used a garage because there was a drain in the floor. This was not the standard 96-hour steady state bioassay. This was designed to be a flowthrough test. The more erudite scientists refer to this as a dynamic test.

What we did, in order to assure test organisms were subjected to the quality of water that was in fact being discharged from the plant, we each day would composite a sample through the 24-hour period. We would use that sample the following morning as a reservoir to feed the experimental animals while another sample was being composited the next 24-hour period, so that every day a fresh batch of discharged material was put into a reservoir about 9 o'clock in the morning and used on a continuous flow basis through the containers with the experimental animals.

The experimental animals I used were caddis fly larvae from the family hydropsychidae. This group of organisms are small larval stages of an aerial form that normally live in the streams. They build weblike cases under stones, they are subjected to all the precipitation and sedimentary materials in the stream, they are probably subjected to the most adverse physical conditions of the stream. The specimens were collected in Whitewood Creek down near Pluma.

This test was a standard test from the standpoint that there was a control setup, 10 organisms in the control, and five concentrations of each of the discharge effluents, one from the sand plant and one from the slime plant. After initial screening the test was set up and was run for 96 hours.

As a result of that, we find that the sand plant discharge as a total discharge, not concerned with component parts of what might be toxic, what might not, the effect of the total discharge was a median tolerance limit of 56,000 ppm. For the slime plant the median tolerance limit was 41,000 ppm.

Now, this is not a very toxic material. This is the freshest material we could get. We are standing right at the pipe using this, and it in no way compares with the theoretical summarization of toxicity that is presented in the report and drawn from literature.

On the strength of the bioassays, I really must take exception to the statement in the EPA report on page 24 that goes like this, quote:

> The concentrations of cyanide, mercury, arsenic, and suspended solids detected in this reach--that is Gold Run--were each sufficiently great to be independently destructive to fish and benthos. Close quote.

I do not agree with that. I think primarily the problem here is a physical problem. I will subscribe only to the suspended solids part. I don't think that the other materials have that degree of toxicity, not when we come out with median tolerance limits of this order of magnitude.

This virtually concludes what I would like to offer at this time. Bear in mind these reports have not yet been completed. I am basing this material on my field notes and so you will have to in a sense consider this as tentative.

Now I would like to introduce a remark or a consideration, and I think I am addressing this primarily to Mr. Ronk and Dr. Shibko.

The effects of methylmercury, which really is not my bailiwick, but I do have a chemist working for me,and last night the thought struck me that this methlymercury is an organic compound and it probably decomposes at relatively low temperatures. So I called this chap up in Los Angeles--remind me to put that on the bill--and asked him if this would break down at cooking temperatures. He thinks that it will. So I am not in a position to argue that it will or argue that it won't. I am just throwing this out for consideration. If you cook a fish do you have less of it than if you eat it raw?

DR. SHIBKO: I can answer this and say that studies have been carried out in Sweden that have shown that cooking or frying fish doesn't change the methyl--

DR. WURTZ: Doctor, I regret to say I am having the same problem the reporter does, you are not coming through to me.

DR. SHIBKO: Studies have been carried out in Sweden that have shown that cooking fish, either by boiling or frying, just doesn't change the methylmercury concentration in the fish.

DR. WURTZ: Does it change the nature--

DR. SHIBKO: It remains bound and unchanged in the fish.

DR. WURTZ: Thank you.

MR. RONK: These studies have also been carried out by the National Marine Fisheries Services.

DR. WURTZ: Thank you. I just wanted that for consideration, that was all.

And I would like to conclude, with the Chairman's permission, with a story with a moral, if I may. And this is the story about an airplane that took off from Portland for Seattle sometime ago and as it got into the air the weather turned particularly bad and it was really foul flying weather. After about a half an hour the captain comes over the intercom system and addresses the passengers and says, "Ladies and gentlemen, I have some news for you, some good, some bad, and I will tell you the bad news first. We don't know where we are and we don't know where we are going. Now I will tell you the good news. We are 10 minutes ahead of schedule." (Laughter.)

Thank you.

MR. STEIN: Thank you.

Are there any comments or questions?

You know, I am encouraged too. I have sat through a lot of these things, and I have to say even though lawyers get paid to be adversaries, I think you can give the accolades to the biologists for differing. Now to be together on this, this is a first for me too.

Maybe we can get you together if you can split samples like the chemists or the engineers do, but I guess that's hard in biology because one of you would wind up with the damsel and the other one with the nymph. (Laughter.)

DR. WURTZ: I am glad you didn't say orgy. (Laughter.)

MR. STEIN: You know, that is the trouble with these biological examples. One fellow always said, you know, "If they split a girl in half it would be my luck to get the part that eats." (Laughter.)

Thank you, Dr. Wurtz.

DR. WURTZ: Thank you.

MR. STEIN: Dr. Hayes.

DR. HAYES: Yes, Mr. Chairman, with your permission I would like at this time to have Mr. Ed Glassgow, the Manager-Treasurer for the Black Hills Conservancy Subdistrict, present his material.

ED GLASSGOW, MANAGER-TREASURER

BLACK HILLS CONSERVANCY SUBDISTRICT

RAPID CITY, SOUTH DAKOTA

MR. GLASSGOW: Thank you, Dr. Hayes. Mr. Chairman, ladies and gentlemen.

My name is Ed Glassgow. I am Manager-Treasurer of the Black Hills Conservancy Subdistrict. The subdistrict was created by the vote of the people in the general election of 1964 for the purpose of water conservation and development in the Black Hills area.

Our subdistrict encompasses the four central counties of the Black Hills area, including Lawrence, Meade, Pennington and Custer Counties. The subdistrict is administered by a Board of Directors elected by the people within the areas they represent. It is funded entirely by a local mill levy on real and personal property and at this time has received a grant and one supplement for the purpose of developing a water quality management plan in the Black Hills area, which includes the entire upper Cheyenne Basin. This grant and supplement quite naturally comes from the Environmental Protection Agency under the 3(C) portion of their planning program. The Governors of both South

Recommendation No. 2 is the temporary facilities on Crow Creek, and here again we would like to offer our comments that we feel that this would be an unreasonable imposition to be made for the short-term benefits that could be derived from this. I think it has been well stated here the reasons for this, so again, for the matter of redundancy, I will not review back to that one again.

The location and composition of buried tailings to be identified, etc., even though these would be carefully ascertained and fully documented, we feel this is fine. However, we find that the deposits to be contained would involve a very unreasonable amount of expenditure that we feel could best be utilized in other conservation measures and possibly this seems to us to be somewhat unreasonable.

We find that point No. 4, the arsenic concentrations to be identified, we would certainly concur with this.

Point No. 5, on the identification of the contaminated fish, if contaminations did exist that there would be a recommendation of nonconsumption of fish. We think, as already has been brought out in this conference, that this could best be left with the entities of the State to determine this and take the appropriate action as necessary. We can see if this were carried out to its ultimate limit that there would be some very frustrating and very detrimental effects that could occur locally on this.

Point No. 6, then, the inventory location of abandoned tailings piles, this would be a fine thing if we had the appropriate funds to take care of it and to do all of these things, but here again I think we are looking at a matter of practicality, and practicality would seem that in light of the extent of the problem and the benefits to be derived that there would certainly be some question as to the feasibility of this one.

No. 7, of course, the water quality standards, we would certainly again concur with.

So in the light of these comments, I would again like to say I am very appreciative to be able to be here at this and to respond to your study, and we would encourage a close cooperation between your organization and ours.

And just so that you might understand a little bit better what we are doing, Mr. Hodgins, I would like to hand you this packet of pamphlets here which are for public distribution to identify what we are doing in the Black Hills area and again thank you for allowing me to be here, sir.

MR. STEIN: Thank you.

Are there any comments or questions?

If not, thank you very much, sir.

MR. GLASSGOW: Thank you, Mr. Chairman.

MR. STEIN: Dr. Hayes.

DR. HAYES: The next person I would like to call to present testimony would be Jim Hanten from the Department of Fish, Game & Parks, State of South Dakota.

ROBERT I. HANTEN
FISHERIES STAFF SPECIALIST
SOUTH DAKOTA GAME, FISH & PARKS DEPARTMENT
PIERRE, SOUTH DAKOTA

MR. HANTEN: Thank you, Dr. Hayes.

Mr. Chairman, I have a statement which I would like to have submitted for the record.

MR. STEIN: Without objection, that will be entered into the record as if read.

MR. HANTEN: The Department of Game, Fish & Parks recognizes there may be a potential problem due to mercury and other heavy metal contamination of fish in the Cheyenne River system below Whitewood Creek and in the Cheyenne Arm of Oahe Reservoir. We have relied upon and will continue to rely upon the South Dakota Department of Health to determine if a public health hazard exists and if sport fishing should be curtailed to the point of nonconsumptive use of the fish.

The primary reason for this conference, as requested by the Governor, is to address "the problem of actual or potential mercury toxicity to humans and to methods of control, if such health hazards are demonstrated, and secondarily to the significance of cyanide discharges. The occurrence, distribution, and significance of heavy metals other than mercury may concern the conferees as well."

The Report on Pollution affecting Water Quality of the Cheyenne River System, Western South Dakota, contains some insinuations and inconsistencies which should be brought out. One inference is that the people have not been told of the mercury contamination problem. The Department of Game, Fish & Parks released four separate news articles regarding the mercury testing of fish in South Dakota. These were dated: July 10, 1970, November 27, 1970, December 22, 1970, April 9, 1971.

The mercury concentrations of fish flesh in the Upper Cheyenne Arm and Foster Bay area of Oahe Reservoir varies so greatly from sample to sample that something must be wrong with the analysis technique, the sampling size, or the sample array. And by array I am talking nere of grouping of size, the size of fish. A good case in point is the walleye sample results. They vary from a high of 0.88 ppm to a low of 0.12 ppm within 18 days of sampling time. Other fish samples exhibit the same inconsistencies.

It does not appear that the results are valid enough to take such a major step as to stop all consumptive sport fishing and commercial fishing.

We feel that because of the doubt about reliability of the mercury tests that the adequate samples should have been run in duplicates by different laboratories with agreeable results in order to make recommendations for action as has been made.

And Mr. Stein, I think you mentioned this morning that this is generally the way things are taken care of. I don't believe it was done in this case.

We believe that this conference must follow the course outlined by the Governor and finally the final conclusion of the conferees be used for the Department of Game, Fish & Parks direction.

Thank you.

MR. STEIN: Thank you.

I have just been notified that about 80 percent of our samples were done by two laboratories. But I do think we have to distinguish a little bit when we are--I think your question about the array of the samples or when we are dealing with biological specimen always comes up in this field. One, we are dealing with an effluent coming out of a pipe and we split the samples. We have had remarkably uniform results between the industry, to whom we have given part of the sample, and our own laboratories. The techniques of analyzing for mercury in the laboratory are pretty well set up.

Now, this does not say there isn't a spectrum of difficulty. The easiest way to sample the mercury or get the mercury is in water. The next most difficult, as I understand it, is in flesh, like in fish flesh. The third most difficult is in muds. Sometimes we experience extraordinary difficulties, when the mercury is in combination with other industrial wastes that provide interference, but this isn't the case here.

But your other point is something that we have to consider. In other words, we have doublechecked these samples. The question that you have, when you are dealing with fish flesh or you are dealing with any biology, is that you can't duplicate that organism the same way you can get consistency with effluent coming out of a pipe or a 24-hour composite. We always have to recognize that when we move in--I think the Food and Drug Administration has indicated how they work that with this slew of statistics--we are not going to go out in the ocean, pick up two tuna, and expect to find in the vagaries that these tuna had in their lives that you are going to get the same kind of consistency that we can if we go to a steel mill pipe on two successive days and take the samples. The likelihood is we are going to get more consistency when we don't have a living organism intervening.

When we are looking at some of the disparity in the tests, I think we can attack and we will work this out with the State, work out the methodology so we are accurate. I think the Food and Drug Administration has probably been grappling with this problem more consistently than anyone else, but when you are dealing with a biological organism and you have to analyze this, you have to expect a certain amount of variety in each organism you pick up.

MR. HANTEN: We recognize the difference in values in biological organisms.

MR. STEIN: Yes.

MR.HANTEN: This is well recognized. But we felt that these ranges were quite large and that they did present to us some question.

Also I think that my recommendation would be that we continue a testing program and establish an adequate testing sequence and program in order to establish this more clearly.

MR. STEIN: Let me again agree. We have run into this problem before, particularly in the mercury problem. I think we have received, and I am talking about regulated industries, now, the highest degree of consistency in testing that I have experienced in my field since I have been in it, and that is well over 25 years. In other words, when the State and the Federal regulatory Agencies and the industries took the samples and split them three ways, when we got the results from all three they were almost on the nose, consistently. We have had practically, and this is what I want to get at, throughout the country in this field no argument about the data. If there is any question about the reliability of the data, I have every confidence that by the techniques we have employed in other places of splitting samples and exchanging data, getting our laboratory people to visit you, you people to visit our lab to see how this is done, we can work out a uniform technique. We have found that once we have done this we have eliminated all these discrepancies. This is one of the things we will probably talk about in the executive session.

MR. HANTEN: Yes.

MR. STEIN: But I am sure this can be done.

MR. HANTEN: Yes.

I have no further comments.

MR. STEIN: Thank you very much.

Dr. Hayes.

DR. HAYES: Yes. Thank you, Mr. Chairman.

I would like next, if I may, to call Mr. Kent Hudson, who is the Plant Manager for the Mines Development, Inc., in Edgemont, South Dakota. I think you will remember this was in reference to the uranium milling and mining.

MR. STEIN: Yes.

KENT L. HUDSON, PLANT MANAGER
MINES DEVELOPMENT, INC.
EDGEMONT, SOUTH DAKOTA

MR. HUDSON: Mr. Chairman, conferees, ladies and gentlemen. I have a very brief and, if you please, interim statement to make on behalf of my company. I am requesting permission to delay for one week any comments or statements regarding the report entitled "Evaluation of the Impact of the Mines Development, Inc., Mill on Water Quality Conditions in the Cheyenne River," which was submitted by the EPA, Region VIII, Denver, Colorado, on September 1971. I received this report at approximately 10 a.m. yesterday morning and as yet have not had sufficient time to evaluate its contents and suggestions and recommendations. I shall submit a written statement to this committee within one week.

Thank you.

MR. STEIN: The record, as we indicated, will remain open a week.

Are there any comments or questions?

MR. HUDSON: Sir?

MR. STEIN: I am asking if there are any comments or questions.

DR. HAYES: Mr. Hudson, basically the recommendations made by the report, I think there were four that I remember, would there be any violent disagreement, do you feel, on the basis of those things?

MR. HUDSON: I think there will be some disagreement, yes.

DR. HAYES: I see. Thank you.

MR. GRIMES: May I ask a question, Mr. Chairman?

MR. STEIN: Yes.

MR. GRIMES: The recommendation also provided for an interim settlement or control of those sand piles with respect to wind and water erosion. This compared to final disposition, the suggestion being made that it be put back in the mine excavation.

MR. HUDSON: Yes, sir.

MR. GRIMES: Do you have anything that you wish to express at the present time as to the value or the practicability of that first interim or an interim as compared to a final solution for it?

MR. HUDSON: What preliminary investigation we have made would indicate that because of the angle of repose on the sands, covering of these sands with asphaltic base material, a petroleum base material, would present, in our estimation, a greater hazard than now exists. This is due primarily to the oxidation of the material, subsequent cracking and spotting, should open cracks be made, and subject this pile to even more violent erosion.

DR. HAYES: I have nothing further.

MR. STEIN: Thank you very much, sir.

MR. HUDSON: Thank you.

(The above-mentioned statement follows.)

MINES DEVELOPMENT, INC.
P. O. BOX 49. EDGEMONT. SOUTH DAKOTA 57735

October 27, 1971

Mr. Murray Stein
Chief Enforcement Officer - Water
Water Quality Office, Room 1111
Crystal Mall No. 2
Washington, D. C. 20242

Dear Mr. Stein:

Enclosed are statements for the record as promised during the E.P.A. Enforcement Conference held in Rapid City, South Dakota, October 19, 20 and 21, 1971.

Please advise if you require more information or data. Thank you.

Very truly yours,

MINES DEVELOPMENT, INC.

K. L. Hudson
District Manager

klh:lh
cc: Dr. R. H. Hayes, M. D.
State Health Officer
Pierre, South Dakota

Mr. R. C. Schenk
Mines Development, Inc.
Chicago, Illinois

The following comments and suggestions are offered for the record in reply to the report entitled "Evaluation of the Impact of the Mines Development, Inc. Mill on Water Quality Conditions in the Cheyenne River" presented by the Environmental Protection Agency, Region VIII, Denver, Colorado at Rapid City, South Dakota on October 19, 1971 Enforcement Conference Hearing.

Mines Development, Inc. is, and has been, cognizant of the fact that uranium mill wastes constitute a potential pollution problem. The Company operating philosophy and procedures dictate that all wastes shall be impounded or stockpiled within the restricted access boundaries of the Company premises in concurrence with all known governmental agency regulations.

It is indicated in the reference report that any contamination of the Cheyenne River which might be attributed to the loss of uranium mill wastes is slight in comparison with presently accepted water quality standards. Independent studies by Company personnel and certified laboratores verify this. Mines Development does recognize, however, that containment of all waste materials to the ability of the practical engineering parameters of its milling operation is an absolute necessity. In view of this, the following comments are directed at certain portions of the above report.

1. Page 12, title III Recommendations, subtitle I.

   A. Recommendation #1 is for the sealing of all retention ponds. MDI concurs that none of the ponds should be allowed to seep. Retention ponds, on the mill premises, were so constructed as to meet the requirements and guidelines set forth by the primary governmental regulating agencies at the time of their construction. This included soil sampling, dike slope control, proper packing techniques and establishment of keyways. It is recognized that, due to the age of the ponds, some deterioration may have taken place. Unusually high solution levels can or have complicated this problem by subjecting the embankments to greater pressure. It was determined by the Company that the best method of eliminating any potential seepage was to commence a systematic withdrawal of fluids and abandonment of the oldest ponds first. This plan was commenced in 1970 with the abandonment of Pond #2. Pond #1 is now static and fluid withdrawal should commence in early 1972 with elimination of this unit anticipated in mid-year. Pond #3 will follow in sequence.

   B. The feasibility of re-sealing the ponds does not appear practical. The large amounts of "slime tailings", composed of clay-sized materials, now reposing on the bottoms of each pond act as sealing solids. The sidewalls and dikes are composed of compacted clay and clay-loam materials. Removal of the present slime tails in order to seal the pond bottom with a material such as bentonite, seems self defeating. This would only create another problem of what disposal is to be made of the uranium slime tails removed.

   It is believed that the simple lowering of present solution levels with subsequent abandonment will forestall any potential future seepage.

2. Page 12, Title III Recommendations, subtitle 2.

   A. Recommendation #2 calls for a two-phase program regarding the stabilization and/or removal of all uranium sand "tailings". Mines Development, Inc. concurs that long-term water and wind erosion might present a potential pollution situation in the effect that sands of a "foreign" nature could conceivably enter a "natural" environment, i.e. "barren" tailings derived from a distant geological formation and chemically treated to remove its metallic values, may be windblown into the Cheyenne River. It is recognized that the sand tailings may contain minute amounts of radio-active material. No data is presently known to exist that indicates a particular volume of sand might enter the river system in a given period of time nor of the potential short-term or long-term effect in increasing the present radio-active norm of that natural system.

   B. Efforts by Mines Development, Inc. to insure the stability of the sand tailings has been attempted. Methods employed were the establishment of drift fences and dikes and the use of contouring. Natural packing, crusting and classification has stabilized portions of the stockpile to a small degree. Disturbance of these areas is most undesirable. Vegetation growth has been encouraged but, to date, is nominal.

   C. Several methods of stabilization by covering have been studied and rejected as being too short-lived to be practical. The use of plastic or petroleum based materials would perhaps provide a good mat that would offer temporary resistance to wind erosion. It is believed that this material would age and deteriorate quite readily and would then crack or peel. At this point, the underlying sand would be exposed to a greater concentration of spot erosion. The use of top soil, assuming it can be applied and held in place, appears to be unsatisfactory. It is believed that the sand, being a good aquifer, will not retain sufficient moisture to provide the top soil with the required long-term moisture needed for vegetation. As this region is classified semi-arid, the lack of vegetation would ultimately expose the top soil to rapid erosion.

   D. The second part of recommendation #2 is for the ultimate disposal of all sand tailings by storage in abandoned open-pit mines. Mines Development, Inc. concurs that this proposal is commendable but, from the Company's viewpoint, economically prohibitive. The amount of sand stockpiled at the mill site is estimated to be 1.5 million tons or approximately 1.1 million cubic yards. To move this amount of material 16 to 18 miles would require an investment in excess of the Company's capabilities. It is suggested that, if the sand tailings are judged to be of such consequence to the environment of the Cheyenne River system that complete removal is necessary, public assistance would be mandatory.

3. Page 12, Title III Recommendations, subtitle 3.

   A. Recommendation #3 suggests the estabishment of monitoring stations downstream from the mill-site for the purpose of determining the extremes in chemical and radioactivity concentrations. Mines Development, Inc. has conducted radioactivity monitoring for many years under the guidance of professional consultants considered expert in the health physics field, both upstream and downstream from the mill and concurs with the recommendation provided that the monitoring be established at stations upstream as well as downstream. Company records indicate incidents where the radium 226 levels have been higher upstream thandownstream.

Mines Development, Inc. wishes to acknowledge the help and suggestions provided by the State and Federal employees during the many surveys. As in the past, the Company will cooperate to the fullest extent with all agencies concerned in the attempt to acquire an equitable and satisfactory solution to any potential uranium pollution problem.

Thank you.

MINES DEVELOPMENT, INC.
SUSQUEHANNA-WESTERN, INC.

KHudson
K. L. Hudson
District Manager

lh/10/27/71

DR. HAYES: I would next like to ask Dr. R. J. Emerick, from South Dakota University at Brookings, to make a statement.

DR. ROYCE J. EMERICK
PROFESSOR OF BIOCHEMISTRY
SOUTH DAKOTA STATE UNIVERSITY
BROOKINGS, SOUTH DAKOTA

DR. EMERICK: Mr. Chairman, conferees, ladies and gentlemen.

I am Royce Emerick, Professor of Biochemistry, South Dakota State University.

The Experiment Station Biochemistry Department of South Dakota State University, of which I am a member, appreciates having been invited to attend this conference.

Our interest in mercury in our environment is not one of long standing. On the other hand, we began some research on this element about one year ago, so we have some background in it. To date, our review of the literature has impressed us most with the need for additional investigations on the subject. The data in the Report on Pollution Affecting Water Quality of the Cheyenne River System of Western South Dakota suggest a potential problem of mercury toxicity, and having seen them we are hopeful that we may undertake a more vigorous and, with others, a more thorough investigation of this matter than our original plans have called for.

We feel that we have the expertise and facilities that will allow us to make a significant contribution to the understanding and resolution of the problem. We hasten to admit, however, that we cannot begin to cover this matter by ourselves, and we shall be pleased to join with those at other institutions in this State in a coordinated research program. In our opinion, the multidisciplinary and the interinstitutional approach provides the diversity of philosophies and methods essential to the assurance of objectivity in an area where emotions can cause bias.

We look forward to assisting in a cooperative effort to resolve those problems relating to mercury in our environment.

Thank you.

MR. STEIN: Thank you, Professor.

Any comments or questions?

If not, thank you very much, sir.

DR. HAYES: Mr. Chairman, the next gentleman I would like to call is Mr. Don Kurvink, who is on the staff of the South Dakota Comprehensive Health Planning Agency.

Don.

DONALD KURVINK, ASSOCIATE DIRECTOR
STATE OFFICE OF COMPREHENSIVE HEALTH PLANNING
PIERRE, SOUTH DAKOTA

MR. KURVINK: Mr. Chairman, conferees, ladies and gentlemen.

I have a printed statement which I will read and also have some remarks that I wish to insert.

My name is Donald Kurvink. I am Associate Director of the State Office of Comprehensive Health Planning. I would like to make a statement as to how the deliberations and findings of this conference may have considerable impact in relation to health program planning in our State.

The Office of Comprehensive Health Planning has been delegated responsibility for the development of State plans for the provision of services relating to health, including environmental protection services. This is accomplished by working with the providers of the services as well as the consumers, which in most instances will be the individual citizen or his representative. In addition, the State Office assists the District Planning Offices which are now being formulated within the State. This assistance may include the provision of information in the evaluation of environmental problems so that program priorities can be established for the District Plan.

D. Kurvink

A basic requirement in the development of plans, and I am sure most of you agree in this, is the availability of reliable facts regarding the problem as well as possible methods which could be used to control these problems. Consequently, our purpose in participating in this conference is to obtain information which may have application in the development of State and district environmental plans. Information obtained may also have rather current usage in the preparation of an environmental statement which has been requested by the Office of the Governor.

It is the contention of the Office of Comprehensive Health Planning that the proper usage of correct facts in the development of a rational plan for the protection of the environment holds considerable promise as an alternative to the rather fractionated and sporadic emphasis about environmental problems which we have experienced in the past. The mechanism which exists for local input into the plan development is an important factor which should help in the obtainment of support for programs which are to be conducted. It must be emphasized that the success in this planning effort will be based in great part upon the belief that the general public, industrial management, and governmental officials will, in most instances, take corrective or preventive action on environmental problems after they are 1) fully informed as to the problem and the action which is necessary, and 2) the action to be taken is placed within a practical and acceptable framework or, namely, a plan.

Now I would like to digress from the printed statement and comment on these two important factors. These are important points in planning which I would like to amplify.

Since considerable question appears to exist in regard to the standards to be utilized for various waste constituents, I appreciate that the conference participants have done more than merely present information to substantiate implementation of the standards in their present form. Both the known and the unknown about the hazard should be reviewed in detail and decisions be made as to what further information will be necessary to derive acceptable standards.

It is hoped that the summation and recommendations of the conference will speak to the need for additional substantiation of these standards. Planning for environmental protection programs must be based upon technical support which will not be vulnerable to significant future challenge. Otherwise the entire pollution control effort will undoubtedly be subjected to partial or complete failure.

Several years of effort have gone into the water pollution control programs in South Dakota which we do not want jeopardized by lack of credibility.

Even though the problems under consideration in this conference may have developed to the point where the title "enforcement conference" is appropriate, it is hoped that participants realize that the information presented may well have application in the establishment of programs which can prevent similar environmental situations in the future. It is the intent of the Office of Comprehensive Health Planning to assist in making this possible through the review and utilization for plan development of the information contained within the summation and recommendations of this conference.

Thank you.

DR. HAYES: Thank you, Don.

MR. STEIN: Thank you.

Are there any comments or questions?

If not, thank you very much.

DR. HAYES: Mr. Chairman, I would like at this time to introduce a paper entitled "Mercury Content of Human Tissue During the Twentieth Century." by Jack Kevorkian and colleagues from Saratoga General Hospital, Detroit, Michigan.

Rather than read the paper and review its contents, which I am sure to all scientists would be controversial, I wish to submit it to the conference and the conferees to further make the point that we hope to make that there is some question about available data on the mercury problem and, although a lot is available, many people disagree with the conclusions which have been reached.

MR. STEIN: Do you want this to be as read in the transcript or an exhibit?

DR. HAYES: An exhibit, if you please, yes.

MR. STEIN: This will be included as an exhibit.

(The above-mentioned paper, marked Exhibit 4, is on file at EPA Headquarters, Washington, D. C., and the Regional Office, Denver, Colorado.)

DR. HAYES: For your information, I think all conferees have a copy of that.

MR. STEIN: Yes, and I think this paper has been published anyway.

DR. HAYES: Yes, it has already been published.

MR. STEIN: Right.

MR. HAYES: Now, I have another gentleman who would like to make a statement, Mr. Norman Nelson, Chairman of the Black Hills Group, Sierra Club. Will you come forward, Mr. Nelson, and make your statement, please.

NORMAN E. NELSON, CHAIRMAN
BLACK HILLS GROUP OF THE SIERRA CLUB
RAPID CITY, SOUTH DAKOTA

MR. NELSON: The Sierra Club was founded in 1892"to explore, enjoy and preserve ...scenic resources of the United States and its forests, waters, wildlife,and wilderness ...and to enlist public interest and cooperation in protecting them." In the 80 years since then the club has grown to national prominence and a role as a spokesman for conservation and preservation of our Nation's scenic resources.

The Black Hills Group of the Sierra Club which I represent started about two years ago from a nucleus of citizens who were concerned about the protection of the Black Hills from development which would degrade the scenic environment of the area. The Group now has nearly 60 members throughout South Dakota.

The issue today, however, is not one of protection but of attempting to salvage the present environment from the mistakes of the past. We have now a chance that is seldom given, a chance to stop and begin over again. The Black Hills Group urges that this opportunity be taken now, before further postponement increases the problem even more.

I do not speak today as a technical expert, nor as someone with a political ax to grind, but as a concerned lifelong citizen of the Black Hills and as spokesman for a group of concerned citizens.

This concern is not limited to the Black Hills. Last weekend I attended the meeting of the Rocky Mountain Chapter of the Sierra Club. This includes North Dakota, Nebraska, Kansas, Oklahoma, Wyoming, and Colorado, as well as our South Dakota group, in Chadron, Nebraska. The representatives of the various groups questioned me sharply about why the Whitewood Creek pollution continued unabated, and urged our maximum effort in support and working for an end to the pollution. These people spoke not only as Sierra Club representatives, but also as individuals whose memories of visits to the Black Hills included the appearance of a black and stinking stream. I am here today to express to this hearing their concern about this problem and more especially the concern of the Black Hills Group for the alleviation of this pollution, which is not merely aesthetically offensive, but also poses a real and current threat to the waters into which Whitewood Creek drains.

As an expression of our great concern about the pollution of Whitewood Creek and the waters of which it is a tributary, the Black Hills Group of the Sierra Club has gone on record as supporting the Lead-Deadwood Sanitary District in its proposal for a settling pond to alleviate the present contamination of the stream by Homestake tailings and chemical or other discharges, and by raw sewage from the nearby communities.

Our letter of last May 13 is already part of the record of this hearing. As I said, we are not experts; we can only weigh the opinions of the experts and form our conclusions as concerned laymen. It is our opinion that the settling pond is the only feasible solution, and I want to stress again our hope that it can be constructed without additional delay. Each day that passes without action is another day of environmental and ecological damage.

I would also like to reiterate briefly one point from our letter: "We...urge maximum care and precautions for the environment during both the construction and the operation of the settling basin."

Thank you.

MR. STEIN: Thank you.

Are there any comments or questions?

If not, thank you very much.

Dr. Hayes.

DR. HAYES: Mr. Chairman, I at this point in time would like to move for a brief recess in order that the State's panel or the State's conferees may caucus and formulate at least an orderly statement of our summaries and wishes the same as the Federal people did the first day.

MR. STEIN: To make that as part of the public presentation?

DR. HAYES: No, it is just for the conference at the executive session.

MR. STEIN: Let's see if we can arrive at a meeting of minds, Doctor. I think we can set the executive session off a little bit, but I do think that for the people here, we should try to conclude the public session now if we may. Is that agreeable?

DR. HAYES: Yes.

MR. STEIN: Are there any other people that you have?

DR. HAYES: I am sorry, I was out of order.

I have no others on my list unless there are others who have come in the room who wish to make a statement.

MR. STEIN: Does anyone else wish to make a statement? Let me indicate what the procedure will be.

Without objection, we will simply grant Dr. Hayes' request and ask them how much time they would want to caucus before we go into executive session.

I wonder if you could give me an estimate of that now, because I would like to indicate to the people when we will be back in public session. Is that possible?

DR. HAYES: Yes, sir. About 30 minutes.

MR. STEIN: About 30 minutes? It is 2:20 now. I would estimate that we will be prepared to make a public statement at about 5 o'clock. I would like to also say at this point that if no one else has anything to say, this will terminate the public participation in the conference. If this is so, what we will do is as follows:

We will recess for a half hour and then go into executive session down the hall. Hopefully we will be able to formulate some conclusions and recommendations, and at about 4:30 or 5 o'clock we will reappear and make these public. The practice we have followed is that we will then adjourn the meeting. Speaking for myself, I will be available for questions and, generally speaking, we will allow anyone who wants to talk to any of the conferees to do so individually and ask them any questions, but we will terminate the conference after reading the conclusions and recommendations.

With that we will stand recessed, executive session in a half hour, and reconvene in open session at about 5 o'clock. If we have any change in that time we will let you know.

(RECESS)

MR. STEIN: Let's reconvene.

While we indicated we were going to get to executive session, there have been two people here who didn't hear the announcement and their names weren't up. But we certainly want to hear everybody.

Mr. Hardy, will you come up? We will start with you.

LEROY HARDY

SOUTH DAKOTA FARMERS UNION
STURGIS, SOUTH DAKOTA

MR. HARDY: Mr. Chairman, conferees, ladies and gentlemen. I do appreciate you taking this extra effort to listen to my brief and very broad statement.

I am Leroy Hardy, representing the South Dakota Farmers Union, and I would like to have this statement made a part of the record. We have just recently completed our State convention and I want to quote in part from our policy statement.

In part the South Dakota Farmers Union policy statement relative to water pollution and environment, and here I quote,

> We agree in principal with the South Dakota Committee on Water Pollution that anything within reason should be done to supply our population with pure, nonpolluted water.

> We would ask that more stringent inspection be enforced on refuse and runoff from cities and towns, manufacturing and processing plants, including the Homestake Mining Company, where it is polluting the water for a long distance downstream.

And I am still quoting:

> We support the Save Centennial Valley Association in their efforts to prevent their productive valley from being used for the disposal of industrial and municipal wastes.

This concludes the quote.

Without pretending to be a technical expert in these fields, there are a few questions that have not been answered. How would construction of the proposed disposal dam affect underground water recharge supplies, both surface water and artesian? Would these recharge sources be contaminated? Would the openings in the geological formations become sealed off so as to affect the normal flow of underground water?

Another point not directly related to environmental problems: Is the right of eminent domain being abrogated when 99 percent of the solid wastes in this proposal come from a private corporation and only one percent of the solid wastes come from the cities of Lead and Deadwood?

These questions have been underlined in a report by the United States Corps of Engineers related to its investigation of flood and water resource problems in the Cheyenne River Basin of South Dakota and Wyoming. One of the proposed projects was a suggestion for a flood control and recreational dam on Bear Butte Creek in Boulder Canyon. This is just above Sturgis, between Sturgis and Deadwood. This proposed dam was deemed infeasible at this time and one of the reasons given was, and I am quoting direct from the May 19, 1971, issue of the Sturgis Tribune:

> However, geologic conditions in the Black Hills region have created a unique interrelationship between surface water runoff and underground water replenishment so that measures to improve the surface water supply may affect groundwater replenishment and endanger--this says endanger--the dependability of groundwater resources.

This closes the quote.

This seems to maybe just add more to the confusion, but here is the Corps of Engineers suggesting that because of the formations in the Black Hills area this water can go into underground sources.

And another brief sentence here. We understand also that there are problems in the drainage below the Sylvan Lake Lagoon disposal system.

So these are some of the questions that we ask as a Statewide rural organization.

Thank you.

MR. STEIN: Thank you, Mr. Hardy.

Any comments or questions?

If not, thank you very much, sir.

Dr. Hayes.

DR. HAYES: Yes. At this time I would like to ask Mr. Henry Frawley, President of the Save Centennial Valley Association, to come forward and make his presentation.

We apologize, by the way, for recessing before you had a chance. We looked and couldn't find you and we are glad you got here in time.

HENRY FRAWLEY, PRESIDENT
SAVE CENTENNIAL VALLEY ASSOCIATION
SPEARFISH, SOUTH DAKOTA

MR. FRAWLEY: Mr. Chairman, conferees, ladies and gentlemen.

Thank you for this opportunity to present you with this information. I do have the feeling right now that a verdict has already been reached in regard to this problem, but I still feel it is necessary and important to have this information made in your permanent record, so I would appreciate it if you would do so.

MR. STEIN: I wouldn't approach it with that attitude. As far as I am concerned, no verdict has been reached.

MR. FRAWLEY: This is very reassuring. Thank you.

I would like to read to you a copy of a letter which was sent to the national and regional Administrator of the Environmental Protection Agency and also to various individuals and organizations who are concerned about pollution problems and the protection of our resources, these organizations, different ones throughout the State and the country.

I would like to read you this first letter, which is a statement which I wish to make on behalf of the Save Centennial Valley Association.

I should probably preface my remarks by telling you that I am President of the Save Centennial Valley Association. I am also a member of the Lawrence County Board of Supervisors for the Lawrence County Conservation District. I am also Vice-Chairman for the Lawrence County Resource Conservation and Development Committee. And I am Manager of the Frawley Ranch in Centennial Valley, which has been owned and operated by my family there since 1876.

I would now like to read to you this letter which is a statement in behalf of the Save Centennial Valley Association:

> Many residents of the northern Black Hills region of South Dakota have organized the "Save Centennial Valley Association." Centennial Valley is located along the northern edge of the Black Hills between the towns of Deadwood, Spearfish, and Whitewood. The valley was given its name by the pioneer farmers and ranchers who first settled it in 1876, the year in which our country was observing its national centennial. Some of the farms and ranches here are still owned and operated by the same families whose ancestors pioneered this valley.
>
> The area is blessed with an abundance of natural resources and minerals. It has deep and fertile soil; many wells and springs whose water is of superior quality; a large variety of native grasses, plants and wildflowers; an abundance of conifer and hardwood timber; clean, fresh air that is free of unpleasant odors and pollution;

and many kinds of wildlife. Many people come here each year to admire the beauty of the valley, enjoy its natural resources and agricultural production, study its interesting geology and visit the many historical sites.

The Save Centennial Valley Association is offering strong opposition to a proposed plan to construct a stabilization dam for the industrial chemical wastes, sands and slime from the Homestake Mining Company and all the sewage from Deadwood and Lead. This proposed sewage and tailings dam is to be constructed in Centennial Valley, where several hundred acres of historical and productive agricultural land will be laid to waste by the same materials now polluting Whitewood Creek. This plan was conceived by the Homestake Mining Company and is being designed by the Brady Engineering firm of Spearfish.

The Homestake Mining Company has selected Centennial Valley as a site for their tailings dam because it has lots of area for future expansion for this type of wastewater treatment facility. Approximately 600 acres will be taken for the construction of the first dam, which will have an estimated life of only 15 to 20 years. When it becomes filled with the sands and slime from the mine then more land, farmsteads and homes will be taken to build another tailings dam and as this destructive process continues, this beautiful and productive valley will be turned into a wasteland!

Other objections to the construction of a sewage-tailings dam in Centennial Valley are based on the probable contamination of wells and springs. The reason being that the dam will be constructed in an area where the geological formations have been severely broken and fractured by the upheavals that formed the Black Hills. Farmers, ranchers, geologists, well drillers, technicians with the Soil Conservation Service and personnel with the Army Corps of Engineers, who believe that these large breaks and fractures, combined with the large gypsum deposits in the valley, will cause the pollutant materials in the dam to flow into the underground water.

The proposed construction site is considered to be a water recharge area for the underground aquifers. The pollutant materials being dumped into the dam such as detergents, coliform bacteria, mercury and cyanide, may contaminate millions of gallons of underground water for miles away. Also, another harmful effect may be that sands and slime, combined with the enormous hydrostatic pressure on the bottom of the dam, may close or plug openings in the formations that will limit or stop the natural flows of water.

This has already happened in an area just a few miles away from Mt. Rushmore, the national shrine of democracy in the Black Hills. The same Brady Engineering firm of Spearfish designed and constructed, with the approval of the South Dakota Department of Health, two lagoons for the sewage from the Sylvan Lake Hotel Resort near Hill City. The results have been serious contamination of underground water with harmful bacteria and stoppage of the flows of spring water below the lagoons.

There are many people in the community who are aware of the objectionable odors which come from the pollutants in Whitewood Creek and they fear that the odors that will come from this proposed sewage dam will be unbearable.

Another harmful effect of this dam will be that it will create a deathtrap for livestock and wildlife. The quicksand characteristics of the sand and slime from the Homestake Mine have claimed the lives of many animals along Whitewood Creek over the years, and a tailings dam filled with the same materials will be no exception.

Our association will support all efforts to clean up Whitewood Creek, but cannot accept a plan that will spread these pollutants over the county's cropland. This plan will merely transfer the pollution problem from Whitewood Creek to Centennial Valley. The destructive effect of such a dam on agricultural land, scenery, historic sites, water, wildlife and the whole environment of the area is staggering. This may be the cheapest and easiest solution to the pollution problem in Whitewood Creek, but for whom, the taxpayers or the Homestake Mining Company? This is not a solution, but rather an evasion of environmental responsibilities!

Our association is questioning the Homestake Mining Company's use of the Lead-Deadwood Sanitary District's right of eminent domain to take privately owned farmland for the disposal of all its industrial waste and the use of the taxpayer's money to help pay for the construction and maintenance of the project. Are the powers of eminent domain and public funds to be used to construct a waste treatment facility where 99 percent of all solid waste products come from a private industry and only 1 percent from the municipalities of Deadwood and Lead? Is the Federal Government permitted to approve and finance plans for wastewater treatment facilities where a private industry will be the primary beneficiary?

The Homestake Mining Company exerts tremendous economic and political control and pressure in Lawrence County and in the State of South Dakota. Consequently, we are afraid the South Dakota Department of Health and the Lead-Deadwood Sanitary District #1 will not give the Environmental Protection Agency all the facts concerning our position.

We are convinced there are better ways to solve the pollution problems in Whitewood Creek. We are consulting with other local and national engineering firms in order to develop some alternative proposals that will be constructive in nature and not endanger our environment and its natural resources.

We sincerely thank you for your consideration and attention.

Yours truly.

MR. STEIN: Thank you.

Are there any comments or questions?

DR. HAYES: I have a few, Dr. Frawley. In your paper you have documented or made the statement that geologists, Corps of Engineers personnel, well drillers, etc., had substantiated there were problems of underground water contamination, and I imagine you have that documented as to who those people were, in other words the people who made those statements.

MR. FRAWLEY: Yes, sir.

DR. HAYES: Good. We won't get a chance to look at that as conferees. We can only get it by hearing because it will have to be introduced into the record to be looked at later.

The other thing is that I want to make sure that everyone understood as conferees the statement about the Sylvan Lake difficulty. I think the allegation is legitimate. On the other hand, the facts of the matter are not settled and, therefore, I would not want it to be represented as fact that these problems have occurred. The fact of the matter is they may not have at all.

MR. STEIN: Do you want to comment on that at all?

MR. FRAWLEY: No, sir. I just want this information recorded.

MR. STEIN: Thank you very much for that information.

MR. FRAWLEY: Yes.

I have two other sources of information which I have given to the secretary here that I would like to read also and have recorded.

MR. STEIN: Go ahead. Proceed.

MR. FRAWLEY: Thank you.

The Chairman of the Lawrence County Conservation District is not able to be here today, so he asked me to present this statement on behalf of the Lawrence Conservation District.

> On February 18, 1971, the Lawrence Conservation District Board of Supervisors adopted the following resolution:
>
> "Be it resolved that the Supervisors of the Lawrence Conservation District oppose the use of agricultural cropland for the proposed sand and sewage disposal pond or other uses which might destroy the land for agricultural purposes."

H. Frawley

The name of our organization correctly implies that the conservation of our resources is our first concern. Already too many of our acres of Classes I, II, and III cropland have been usurped by Interstate 90 and random housing and industrial developments. However, they did not create pollution problems with which we could not cope.

This plan to cover some 280 acres of Class III agricultural cropland with combined industrial and municipal wastes is laden with pollution problems. The answer to many of these problems, as proposed by the Lead-Deadwood Sanitary District and their engineers, are incomplete, inconclusive, and are not compatible with opinions rendered by geologists, soil scientists, well drillers, and long-time residents of the community.

As a conservation district, we are deeply concerned about the probability of pollution of the ground waters. Admittedly, the Lead-Deadwood Sanitary District report emphasizes the sealing characteristics of the finer particles of the industrial wastes, and, to some extent, this is true. But they failed to report that detergents in the municipal wastes have penetrated these dense sediments in Whitewood Creek to allow liquids, bearing ferro- and ferricyanides, to pollute beyond this barrier.

Geologically, the proposed pond site is underlain by the Red Beds of the Spearfish formation. These Red Beds, themselves, are partially impervious, but they contain strata and random deposits of highly soluble gypsum. Due to these gypsum deposits, the Soil Conservation Service no longer recommends that stock water dams be constructed in this formation because nearly all previously constructed dams in the area have developed "sink holes." These "sink holes" drain the water into lower strata or aquifers. Also, irrigation ditches constructed in the Red Beds have had to be replaced, or bridged, by pipelines because of the dissolution of the gypsum deposits.

Another geologic fact to consider is that these porous formations, tilted upward to the hills to the east, comprise an important underground water recharge area. Pollutants entering the ground here could cause serious contamination of the underground water supplies for a huge area and both for rural and urban users.

The Lead-Deadwood Sanitary District proposes to seal these areas, but their financial allowances for contingencies does not begin to cope with the actual costs of a sealing project of this magnitude.

Another problem that concerns the Lawrence Conservation District is that the estimated life of this pond is to be twenty years, at which time this site will have to be extended down Centennial Valley, covering more good cropland, a sort of a cancerous progression. The some 280 acres is only a part of the 600-700 acres needed for the project and the life of this project could be considerably shortened if the industry involved increases its production, (and its wastes).

Since this is nearly all industrial waste, (99.5 percent solid waste measure), of finely ground igneous and metamorphic rock, plus highly toxic chemicals, it is sterile, and incapable of supporting plant life. In fact, the solid matter ratio is 2,000 parts industrial wastes to 1 part municipal wastes. Thus, the eventual rehabilitation of such a large surface area, in face of the shortage of available topsoil, is more a myth than a possibility. If left exposed to wind erosion, this material, when airborne, creates a highly abrasive local condition such as can be observed along Whitewood Creek.

Now, there being no existing disposal area of this type within our immediate vicinity, the pattern was taken from a silt pond of the Anaconda Copper Company, in Montana. Reliable sources tell us that this is a very unsatisfactory operation.

The South Dakota State Department of Health has endorsed this project and likens it to a sewage lagoon. All of the existing lagoons, under the control of the State Health Department, are used for organic industrial and municipal wastes. This proposed sand and sewage pond will not operate by bacterial action as does a sewage lagoon.

I have enumerated faults in this plan that we feel merit a more thorough study.

The Lawrence Conservation District wants to see the pollution problem cleaned up as soon as possible, but we concur with the Save Centennial Valley Association, in that the plan of the Lead-Deadwood

Sanitary District is not an environmentally sound solution to this problem. In our opinion it is merely the cheapest expedient for removing the wastes from Whitewood Creek.

The State Association of Conservation Districts, at a recent meeting, has resolved to stand with the Lawrence Conservation District in this matter.

Stanton E. Selway, Chairman

MR. STEIN: Does that conclude the statements you have?

MR. FRAWLEY: One more.

MR. STEIN: Any comments on this one?

MR. FRAWLEY: It is very short.

DR. HAYES: Mr. Frawley, you mentioned the land was classed as Class III?

MR. FRAWLEY: Yes.

DR. HAYES: What other classes are there? I am sure I, II, and III, but briefly. I am a novice at this.

MR. FRAWLEY: Just by virtue of my own comment, I would like to make known to you that the Soil Conservation Service just completed a very recent soil survey of Centennial Valley and the Centennial Valley site, and they have found that the majority of the land, at least 60 percent of the land in this particular proposed site, are Classes II and III and also Class IV. There is some Class VI land in the area, but the predominant classification of the soils in this area will be III and IV. And they have pointed out to us that the Class III and IV land, of course, is the best that we have in Lawrence County.

This is some information which is available at Soil Conservation Service offices in the Black Hills and it is very recent and very up to date.

Does that answer your question, sir?

DR. HAYES: Yes. The area where the Centennial Valley tailings pond site is located is Class--what--III land, you say?

MR. FRAWLEY: It is a mixture. There are Classes III, Classes IV.

DR. HAYES: Oh.

MR. FRAWLEY: And this is the predominant classification of the land in the site. There is some Class VI. But the majority of it is Class III and IV.

DR. HAYES: O. K. Thank you.

MR. FRAWLEY: I just have one other piece of information which I would like to present to you which I hope will explain to you why we have continued concern about our underground water. We have a Lawrence County Resource and

Conservation Development Panel in Lawrence County which receives and reviews projects for investigation. During the past few months we have been reviewing proposals which have been made to our panel and just recently we had to reject six of these proposals. These proposals were investigated by the Corps of Engineers and they were investigated by the Soil Conservation Service, and I would like to read them for you.

The first one was a proposal to construct a recreational dam in what we call False Bottom Creek. The Corps of Engineers determined that the project was not feasible because of high construction cost, water holding capacity of the reservoir was very risky, and storage reservoir was not adequate for flood control.

A second proposal considered was a flood control dam for Boulder Canyon. Again the Corps of Engineers gave this project low priority because storage reservoir was not adequate and excessive seepage and high construction cost.

A third project we reviewed was the sealing of a dam at the Tomahawk Golf Course. This project was studied by Jim Hyland, a Soil Conservation Service geologist. He made the feasibility study of the project and he reported that previous attempts to seal the dam with Bentonite were failures. Because of the fractured limestone abutments, the cost of sealing the dam would be prohibitive.

A fourth proposal was called the Ryther Recreational Dam. The feasibility of this project again was made by SCS engineers. The site located was in the Red Bed soils and was considered to have poor water holding capacity.

Then there was another project called the Deerfield Creek Dam or the Deer Creek Dam, and a feasibility study was made by James Monahan, SCS geologist. This project was determined to be not feasible because of excessive seepage and high construction cost.

I would like to show you a map which I hope all of you people can see. I have outlined with the red circles these various proposed sites to build recreation and flood control dams in the northern part of the Black Hills. I hope you can see this. I will be very happy to pass this around if you can't.

But I also have shaded in green the Centennial Valley site and you can see the very close relationship and proximity of these proposed sites which have been investigated not by armchair engineers but by geologists in the Soil Conservation Service and also in the Army Corps of Engineers, and they have considered these sites to be unfeasible. It is very difficult for us to understand why if these sites are not feasible, if they are not capable of supporting a water impoundment, how can a Centennial Valley site do so.

I would be real happy to present this to you if you would like to look at it.

Since this seems to be picture-taking display day, I would also like to present you with pictures of Centennial Valley. These colored photographs will show you the agricultural production in the valley. They will show you some of the historic sites, some of the efforts that are being made to develop this area for outdoor recreation, and I really don't think these pictures need a great deal of salesmanship. I think they speak very well for themselves and I would like to present these to the committee.

This concludes the recorded information which I wanted to have for this meeting. I would be very happy to answer any other questions which you may have.

MR. STEIN: Are there any comments or questions?

If not, thank you very much. I don't see any. Thank you very much, Mr. Frawley.

MR. FRAWLEY: Very well.

DR. HAYES: May we keep the pictures for the record?

MR. FRAWLEY: Yes, you may.

MR. STEIN: We will have this as an exhibit, please.

MR. FRAWLEY: And you may keep these.

MR. STEIN: We will keep those as exhibits too.

(The above-mentioned pictures, marked Exhibit 5, are on file at EPA Headquarters, Washington, D. C., and the Regional Office, Denver, Colorado.)

MR. STEIN: Dr. Hayes, does this conclude the presentations?

DR. HAYES: Thank you, Mr. Chairman. I am sure it does.

MR. STEIN: All right. Let me make this announcement again. And I am sorry we missed two, but I know of no other devices other than to make a public announcement in here and if you are not in here, that is too bad. I am very happy that we hadn't dispersed enough and we could get the statements of the last two people and we are really grateful for you giving those to us.

We will proceed as we indicated before. We will take a slight recess and when South Dakota is ready we will go into executive session and try to be out here by 5 o'clock.

(RECESS)

THURSDAY MORNING

OCTOBER 21, 1971

(9 o'clock)

MR. STEIN: Let's reconvene.

First I would like to thank all of you people who have stayed with us this long and worked with us on this. Not the least, I would like to thank our reporter, Virginia Rankin. Again I know some of you people may get disturbed when I keep repeating how long we have worked in this business, but I think from almost the beginning Virginia has been working with us on these projects as a reporter,and I think it says something for possibly her and us that through the years we have maintained a professional independent reporter contract and still use her. That is a wonderful thing. You know, sometimes you wonder how long this is, and I know I met Virginia first when she was single and now her husband is retired, so that will give you an idea how long ago this was.

I would like to take this opportunity to thank Governor Kneip for asking us to come in on this problem. We came in in the spirit of his request, in the spirit of State-Federal cooperation. We have, I think, addressed ourselves to all the areas he asked us to consider and the charges he gave to the conference, and we have come up with conclusions and recommendations which cover all these charges.

I also think that necessarily the conferees have had two very difficult aspects of their job. One, we have had to come up with conclusions and recommendations which obviously would not satisfy everybody. The second thing is we had to primarily be concerned with the protection of the people and the environment. And thirdly, we have to recognize that we are dealing with the outpost of science and investigation in the environmental field, which probably is the reason why the Governor asked us in.

I would like to express my appreciation personally not only for the excellence of the presentations but the careful analytical work that the State representatives have given us and the cooperative spirit that the State people have shown. I know that I, and I am sure the Federal staff also, have learned a lot from this experience and from working with your State representatives. They have been grappling with the same problems that we have; they have been doing it in South Dakota; we have been doing it nationally, and the association with your people has given me some new approaches and new insights of which I am sure we can make good use.

With that I will read the conclusions and recommendations. And I am glad to announce that these are unanimous.

1. Pollution caused by discharges from industry,

municipality, and agriculture, subject to abatement under Section 10 of the Federal Water Pollution Control Act, is occurring in interstate and navigable waters within the conference area.

2. To date, measures taken toward abatement of this pollution have not been accomplished.

3. The delays being encountered in abating this pollution are caused by the complexity of the problem.

4. The Lead-Deadwood Sanitary District proposed treatment facility at Centennial Valley, for domestic sewage and Homestake tailings, shall be constructed and in operation by November 1, 1973, as stipulated in the Federal-State water quality standards. Further, the district shall comply with the following interim dates:

By February 1, 1972 - Plans to be completed;
By April 15, 1972 - Contract to be awarded;
By July 1, 1972 - Construction to be started;
By October 1, 1973 - Construction to be completed.

It is recognized by the conferees that as progress is made on these facilities, a reassessment of the above implementation schedule may be necessary. Semi-annual reports shall be made by the district to the conferees on progress toward the completion of the construction. The conferees regret that some local residents believe that the location of the remedial facilities in Centennial Valley will result in adverse effects which outweigh the benefits which would accrue to the environment.

5.* The Lead-Deadwood Sanitary District, in consultation with the State of South Dakota and EPA, shall determine the feasibility of utilizing the Centennial Valley site as an interim facility for disposal of Homestake Gold Mine tailings prior to the completion of the project. A report on the feasibility of such an interim measure shall be made by the district, the State and EPA to the conferees by February 1, 1972. EPA will provide technical assistance as necessary.

6. The location and composition of buried tailings materials, including abandoned tailings piles, along Whitewood Creek, the Belle Fourche River, and the Cheyenne River shall be ascertained and documented and the rates of release of heavy metals and toxic elements be established by the State of South Dakota and the Environmental Protection Agency by October 1, 1972, and findings reported to the Chairman and the conferees. South Dakota will provide the Chairman of this group.

7. Arsenic concentrations in wells in the Cheyenne Basin shall be determined and documented by the State of South Dakota and the Environmental Protection Agency to ascertain

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* See 593 for changed and accepted recommendation.

whether these sources are acceptable for domestic or agricultural water supply uses and the findings shall be reported to the Chairman and the conferees within six months of the date of this conference. EPA will provide technical services.

8. The State and EPA shall devise a representative fish sampling plan. The Food and Drug Administration will provide advice and statistical support during the conceptual stages of this plan. EPA will analyze the fish according to the plan.

The results of this representative fish survey will enable the State Health Department to fully evaluate the mercury hazard by species. If a hazard is shown to exist, then posting or other adequate public warning measures will be instituted.

The principal goal of this plan is the safe use for food of recreational fish. It is not intended as a sufficient quality control plan for commercial fishermen using these waterways.

9. An investigation shall be made by the State of South Dakota, EPA, and other appropriate State and Federal Agencies, to determine the scope and amount of mercury in the sediments and the amount of mercury in the fish, including the chain of transmission in Oahe Reservoir. The State and EPA will prepare a work plan by February 15, 1972.

Conclusions and Recommendations

10. By January 1, 1973, sealed storage for liquid uranium and vanadium mill wastes at Mines Development, Inc., at Edgemont, South Dakota, shall be provided to eliminate the seepage into Cottonwood Creek and the Cheyenne River. A progress report shall be made by Mines Development and the State to the conferees by July 1, 1972.

11. A plan providing for the stabilization and ultimate disposal of sand tailings from Mines Development, Inc., shall be developed by February 15, 1972. One alternative for ultimate disposal that should be investigated is storage in the excavated portions of the open-pit uranium mine operated by Mines Development, Inc.

12. By July 1, 1972, monitoring stations shall be established on Cottonwood Creek (at the mouth) and the Cheyenne River (downstream from the Mines Development mill) by the State of South Dakota in cooperation with EPA, to determine the extremes in chemical and radioactivity concentrations, as well as the annual average radioactivity concentrations.

13. The State of South Dakota and EPA shall submit semi-annual reports to the Chairman and conferees concerning the progress made in implementing these recommendations, commencing April 1, 1972.

This concludes the findings and recommendations. Do any of the conferees want to say anything at this time?

DR. HAYES: Mr. Chairman, I want to say one thing on behalf of the State. The Governor has asked me to thank all of you participants and your staff for giving us the help you have. I am sure that in the two days of deliberations in which we sat down together we did find some workable solutions to some problems which had plagued us. I think the problem we had with trying to decide what species of fish or when certain species of fish should not be eaten because of levels of toxicity which might accrue from mercury certainly has been a help to us in particular.

The other things which I think face the State and those of us who try to work in behalf of the State to get these things accomplished were probably of greater magnitude in the sense of dollars and time, but certainly outside opinions from experts such as yourselves have been helpful.

I know the Governor wished me to thank you personally and in addition to the Governor's thanks I wish to convey my own.

Thank you.

MR. STEIN: Thank you.

Are there any other comments?

MR. DICKSTEIN: Yes. On behalf of EPA and Region VIII, Denver, Colorado, I would like to thank all of you participants, all the individuals who have made statements at this conference. It seems to me that this is a real cooperative effort; it is a real State-Federal relationship and in the future it will continue this way.

MR. RONK: On behalf of the Department of HEW, we were happy to be invited to this type of conference. I think the Department always stands ready to try and help any State government solve any of their regional health problems whether it relates to food or whether it relates to other medical affairs.

Thank you very much.

MR. STEIN: Thank you all and thank you again, the people in the audience, for participating and staying with us until the end.

With that we stand adjourned.

(Whereupon, at 9:15 o'clock the conference was adjourned.)

November 3, 1971

Change in Recommendation 5, Western South Dakota Enforcement Conference

Murray Stein
Director, Division of
Enforcement Proceedings

I received a call from the State of South Dakota asking that recommendation 5 be changed from "The Lead-Deadwood Sanitary District . . . . for the disposal of Homestake Gold Mine tailings . . . ., to . . ."the disposal of Lead-Deadwood Sanitary District wastes, including Homestake Gold Mine tailings . . . ."

The interim project actually will impound the domestic waste with Homestake's waste, so I see no reason to object to this change and, thus, recommend this change be made.

Irwin L. Dickstein
Acting Director
ENFORCEMENT DIVISION

ILDickstein:mmn

South Dakota
State Department of Health
ROBERT H. HAYES, M.D., STATE HEALTH OFFICER
Pierre

November 11, 1971

In Reply
Refer To: 35.140301

Irvin Dickstein
Chief of Enforcement
Region VIII, EPA
Lincoln Towers Building
1860 Lincoln
Denver, Colorado 80203

Dear Mr. Dickstein:

In regard to recommendation #5 of the Conferees at the recent Western South Dakota Enforcement Conference, to avoid possible legal complications should condemnation proceedings become necessary, it is requested that the recommendation be amended to read as follows (amendment in brackets):

5. The Lead-Deadwood Sanitary District, in consultation with the State of South Dakota and EPA, shall determine the feasibility of utilizing the Centennial Valley site as an interim facility for disposal of [wastes from the Lead-Deadwood Sanitary District, including Homestake Mining Company tailings,] prior... as necessary.

I have discussed this with the other State Conferees, and they are in agreement as to the desirability of the amendment.

It would be appreciated if you would bring this to the attention of Mr. Murray Stein so that the official transcript of the Conference can be amended accordingly. Thank you.

Sincerely,

Robert H. Hayes, M.D.
State Health Officer

RHH:jb

(The following amendment to the Conclusions and Recommendations was submitted after the close of the conference:)

5. The Lead-Deadwood Sanitary District, in consultation with the State of South Dakota and EPA, shall determine the feasibility of utilizing the Centennial Valley site as an interim facility for disposal of Lead-Deadwood Sanitary District wastes, including Homestake Gold Mine tailings, prior to the completion of the project. A report on the feasibility of such an interim measure shall be made by the District, the State and EPA to the conferees by February 1, 1972. EPA will provide technical assistance as necessary.

(The following addenda were submitted for the record by Region VIII, EPA, Denver, Colorado:)

ADDENDUM I

TO

"EVALUATION OF THE IMPACT OF THE MINES DEVELOPMENT, INC. MILL ON WATER QUALITY CONDITIONS IN THE CHEYENNE RIVER"

DISSOLVED MERCURY IN CHEYENNE RIVER, COTTONWOOD CREEK, AND SEEPAGE SAMPLES-1971

Station	Dissolved Hg (ug/l)
1. Cheyenne River just upstream from the State Highway 18 bridge outside of Edgemont.	2.1
2. Cottonwood Creek upstream from mill property at the county road bridge; off State Highway 52.	3.5
3. Cottonwood Creek at the road culvert; downstream from sand tailings Pile No. 2.	4.2
4. Cottonwood Creek at confluence with the Cheyenne River.	1.8
5. Cheyenne River about 1.5 miles downstream from the mill.	0.6
6. Cheyenne River about 6 miles downstream from the mill; at Gull Hill Park.	3.0
7. Cheyenne River at ford on County Road II.	3.2
8. Cheyenne River at State Highway 71 bridge.	0.8
9. Cheyenne River in the headwaters of Angostura Reservoir.	1.8
Seepage into Cottonwood Creek just upstream from the pipeline suspension bridge.	1.0
Seepage into Cottonwood Creek several hundred yards upstream from the pipeline suspension bridge.	2.3

Station	Dissolved Hg (ug/l)
Seepage into the Cheyenne River just upstream from Pond No. 1.	2.2

NOTE: Analyses performed on field-filtered samples by the Division of Field Investigations - Cincinnati, Environmental Protection Agency. With the exception of the seepage samples, the dissolved mercury values refer to 5-day composite samples.

ADDENDUM II

TO

"EVALUATION OF THE IMPACT OF THE MINES DEVELOPMENT, INC. MILL ON WATER QUALITY CONDITIONS IN THE CHEYENNE RIVER"

1. Page 1: In the fourth line, change the superscript 1/ to a/. Similarly, change the footnote designation from 1/ to a/.

2. Page 6: Insert the superscript 1 after the last word on this page.

3. Page 7, Item 2: "Increases" should be changed to "Increased".

4. Page 10, Table I: Insert superscripts 2,3,4, & 5 after U. S. Public Health Service, Federal Radiation Council, International Commission on Radiological Protection (ICRP), and the National Committee on Radiation Protection (NCRP), respectively.

5. Page 11: The following paragraph is to be added after the second paragraph:

   Despite the fact that the increased radioactivity concentrations in Cottonwood Creek and the Cheyenne River do not pose a public health hazard, steps should be taken to eliminate or substantially reduce the radioactivity of the seepage entering Cottonwood Creek and the Cheyenne River. This is consistent with a policy of minimizing the release of radioactive materials to man's environment insofar as is practicable. That is, the waste management program should be the best available provided the specific practices are technologically feasible and economically reasonable. Moreover, elimination of the aesthetically displeasing discoloration of bank and channel areas requires curtailment of the seepage from the retention ponds (or substantial reduction thereof).

   In the fourth line of the third paragraph, insert the superscript a/ after "... high-radioactivity solids..". This change is accompanied by the following footnote at the bottom of the page:

a/ A Sample of drained sands from Pile No. 2 collected during the 1966 study contained 230 pCi of radium-226 per gram dry weight.

6. Page 26: In the second sentence, insert the superscript 6 after "report".

7. A section listing references, Section VII, should be added as the last page of the report and noted in the Table of Contents.

VII. REFERENCES

1. Tsivoglou, E. C., Kalda, D. C., and Dearwater, J. R., "The Resin-In-Pulp Uranium Extraction Process. Mines Development Company, Edgemont, South Dakota", Technical Report W62-17, U. S. Public Health Service, R. A. Taft Sanitary Engineering Center, Cincinnati, Ohio (1962)

2. U. S. Public Health Service, "Drinking Water Standards-1962", Publication No. 956.

3. Federal Radiation Council, "Background Material for the Development of Radiation Protection Standards", Staff Report No. 2 (September, 1961).

4. International Commission on Radiological Protection, "Recommendations of the International Commission on Radiological Protection, as Amended 1959 and Revised 1962", ICRP Publication No. 6, Pergamon Press, New York, New York (1964).

5. National Committee on Radiation Protection,"Maximum Permissible Body Burdens and Maximum Permissible Concentrations of Radionuclides in Air and Water for Occupational Exposure", Handbook 69 (including Addendum I), U. S. Department of Commerce, National Bureau of Standards (August 1963).

6. Federal Water Pollution Control Administration, "Evaluation of the Radioactivity Levels in the Vicinity of the Mines Development, Inc. Uranium Mill at Edgemont, South Dakota, 1966", Technical Advisory and Investigations Branch, Physical and Engineering Sciences Section, Cincinnati, Ohio (May 1967).